15 Cents SEPTEMBER, 1910 $1.00 a year

700911
AUG 30 1911
PUBLIC LIBRARY DETROIT

THE FOUNDRY

Surprisingly Uniform Results Obtained in Steel and Iron Castings with

TITANIUM

The Most Wonderful Alloy for Strengthening all Iron and Steel

Titanium, the new alloy, is winning its way everywhere by its great efficacy in steel and iron castings.

Costs only twenty-five cents and upward for each ton of metal. Insures freedom from blow-holes and pin-holes, releases many impurities, and greatly reduces segregation.

Makes molten metal more fluid, giving greater uniformity, because of more perfect subsidence in mold, *and produces a far more durable product for every wearing part than has ever been achieved by any other alloy--as shown by actual tests.*

PUBLIC LIBRARY OCT 6 1911 DETROIT, MICH.

The Titanium Alloy Manufacturing Company

CHARLES V. SLOCUM, Special Agent

PITTSBURG, PENNA.

Everything You Need In Your Foundry

ESTABLISHED 1874

36 years told us how

TO MAKE

Good Foundry Plumbago

Most Excellent Core Wash

Splendid Core Compound

Highest Grade
Foundry Supplies

Modern, Up-to-date
Foundry Requisites

We Trust You; You Trust Us In Our Belief and Judgment

The S. Obermayer Co.

"Everything you need in your foundry."

CINCINNATI CHICAGO PITTSBURGH

Only The Highest Grades Manufactured

1337
884/A

THE FOUNDRY

Vol. 37, No. 1 Cleveland, Ohio, September, 1910 Whole No. 217

FINISHING and PLATING BRASS CASTINGS

Methods pursued by the National Cash Register Co. in the production of fine register parts — Modeling and pattern departments

By C. Vickers

THAT utility and beauty in castings can be combined, is reflected by the product of the National Cash Register Co., Dayton, O. In appearance, a cash register must be so attractive that, apart from its practical value, it will be in harmony with the most ornate surroundings. To attain this result, each part of the machine must bear evidence of the highest quality of workmanship in the various stages of its manufacture, and the best efforts of the brass founder must be ably supplemented by those of the polisher and plater. The problem in the brass foundry is to obtain the most perfect castings possible at a minimum cost, and to produce an alloy that shall be so uniform in color, as to match with other parts made, not only months, but years before. It will be appreciated, therefore, that a composition of metal once decided upon for certain parts, must be rigidly adhered to, as slight variations in the mixture of a bronze are easily discernible when fitting finished parts together. The beauty of a brass casting lies in its degree of smoothness, color, sharpness of outline and freedom from sand specks, the latter two requirements being entirely dependent upon the skill of the molder. The color depends largely upon the composition of the metal and its freedom from contaminating elements, such as iron, etc., and smoothness is obtained by the use of fine sand in molding, printing-back the pattern, or otherwise treating the surface of the mold so that the pores of the sand are closed, which prevents the liquid metal from sinking into the surface.

For the production of smooth castings, the practice of this concern at present is to rely upon the use of fine sand rather than any treatment of the sur-

FIG. 1—GENERAL VIEW OF THE PLATING ROOM

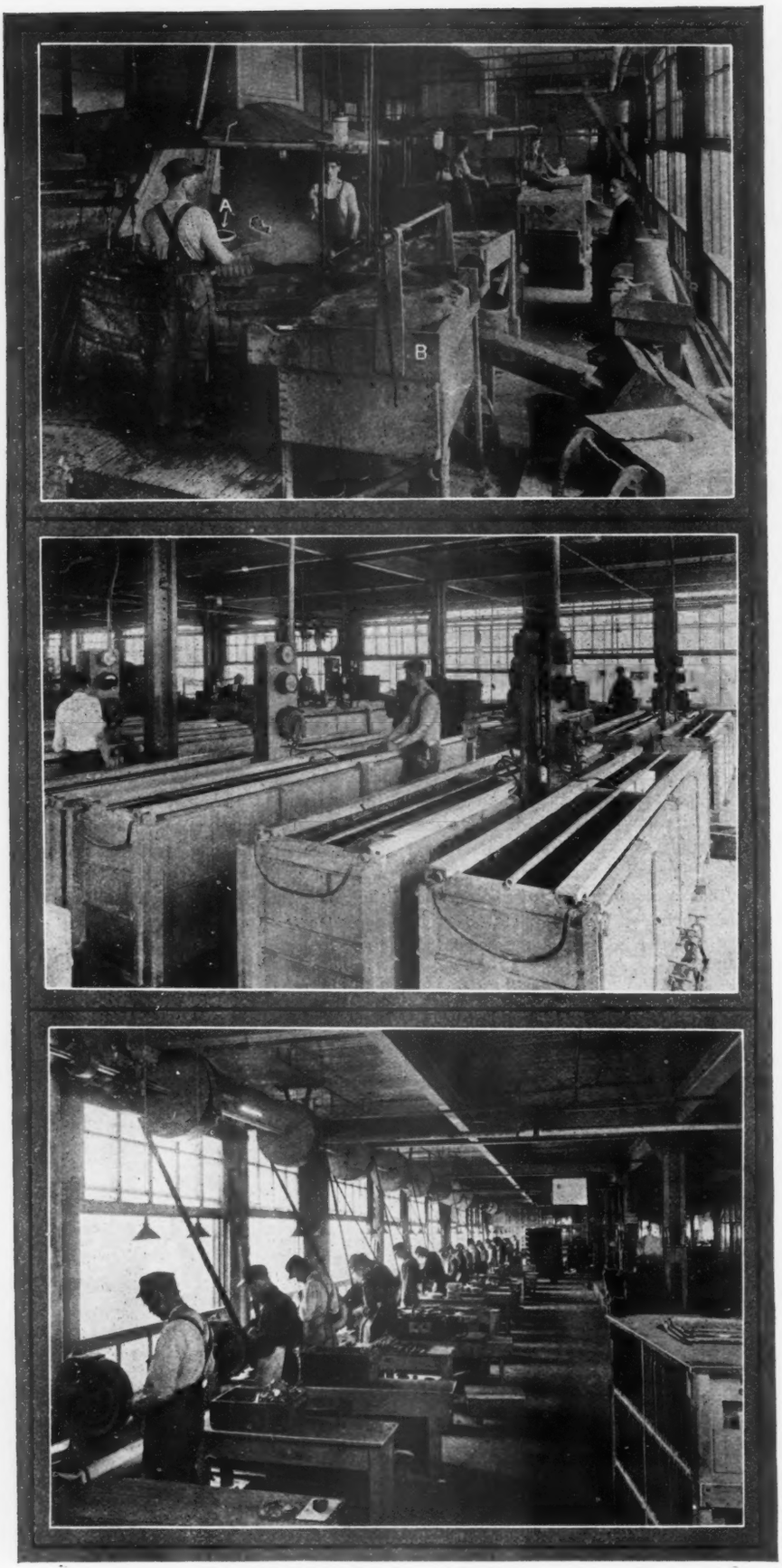


FIG. 2—THE DIPPING ROOM

FIG. 3—TANKS FOR SILVER-PLATING AND JOBBING WORK

FIG. 4—GENERAL VIEW OF THE GRINDING DEPARTMENT

face of the mold. It was formerly the practice to smoke the molds with rosin, but it has been found that by the use of exceedingly fine sand as a facing, the results attained approximate so closely to the smoking process that the latter can be dispensed with. This concern does not purchase prepared sand, but procures it by screening and milling a fine grade of brass sand, and to facilitate the operation, it has been found necessary to dry the sand, which is accomplished by means of exhaust steam, the sand being shovelled into bins containing pipes, through which the steam flows. It is then passed through screens of fine mesh, until the finished product resembles flour. This is then made into a facing and used as such on the patterns. Fine sand, however, will not always make fine castings, as several other considerations intervene, chief of which is the degree of moisture of the sand. If too damp, it has a tendency to lump together in grains, the size of which is largely dependent upon the mesh of the sieve used to apply the facing to the pattern. This condition makes it necessary to ram the mold much harder to obtain the required density of the surface, which, in a green sand mold, may cause a blow. The sand should, therefore, be worked as dry as is consistent with strength sufficient to enable raised parts to withstand the operation of cleaning the mold without breaking or blowing away. Owing to the large amount of such facing required daily, it has been found expedient, by this concern, to utilize machinery to prepare it, but in a small way and for occasional use, this would not be necessary. The jobbing foundry can obtain similar results in the way of fine castings by first baking the sand and then screening it through sieves of the required fineness of mesh. It may be stated, however, that if the drying is carried far enough to burn the sand red, it disintegrates and a finer product is the result, as all organic matter is destroyed by this operation, and the high degree of fineness of the sand does not injuriously affect its casting qualities.

Mixing the Facing.

In mixing a facing for skin dried work, the natural bond of the sand is not always sufficient to enable it to withstand the rush of the metal, consequently, the general practice is to mix it with molasses water or to spray it on the finished mold. A large percentage of the work made by the National Cash Register Co. is skin dried, and for this purpose special stoves have been devised, which were fully described and illustrated in THE FOUNDRY, August, 1909. That the color of the castings shall be as nearly uniform as possible, great

care is exercised in weighing the heats, and all scrap is first run into ingots, thus simplifying the addition of definite proportions to each heat.

Cleaning the Castings.

After the castings leave the sand, they are cleaned by a small revolving wire brush attached to one end of a rod, the other end of which is connected by a knuckle joint to a small shaft and pulley fastened to the bench and driven by a belt. The knuckle joint permits of considerable flexibility of movement of the brush, so that all parts of the casting can be reached, with the same ease as with a flexible shaft. After being brushed, the gates are cut off, and the castings are ground, which generally concludes the ordinary foundry operations. In this case, however, after grinding, they are dipped, inspected, sorted and finally shipped to raw brass stock. The dipping process in the foundry exposes any surface imperfections, such as pin holes, etc., which might otherwise remain hidden, and makes the detection of scrap at this early stage much easier. From the raw brass stock, the castings are weighed and are passed to the grinding department, Fig. 4, where they are ground and faced, this being the initial step in the series of operations leading to their final finish. The grinding wheels are equipped with exhaust hoods, which carry off the dust into the dust collecting system. After the grinding operation, the castings are again inspected and are next delivered to the machine shop, a section of which is shown in Fig. 5.

Profiling Machines.

As most of the castings that make up a cash register cabinet are plates of irregular outline, the operation of the finishing machines is largely confined to cutting and trimming the edges of the castings, and the shapers which perform this operation are known as profilling machines, Fig. 5. It will be noted that each tool consists of a milling cutter carried on a movable head to which the power is transmitted by a belt from a pulley in the form of a long cylinder, at the rear of the machine. This construction permits the cutter to follow the irregularities of outline of the casting, the latter being firmly secured to a fixture or jig attached to the carriage of the machine, which guides the cutter and gages the depth of the cut, thus uniformly machining all of the castings. As it is imperative that the castings be so firmly attached to the fixture as to preclude all possibility of movement while the work is progressing, no half measures would do, and the first method adopted to secure them was by means of set screws. As springing of the thin

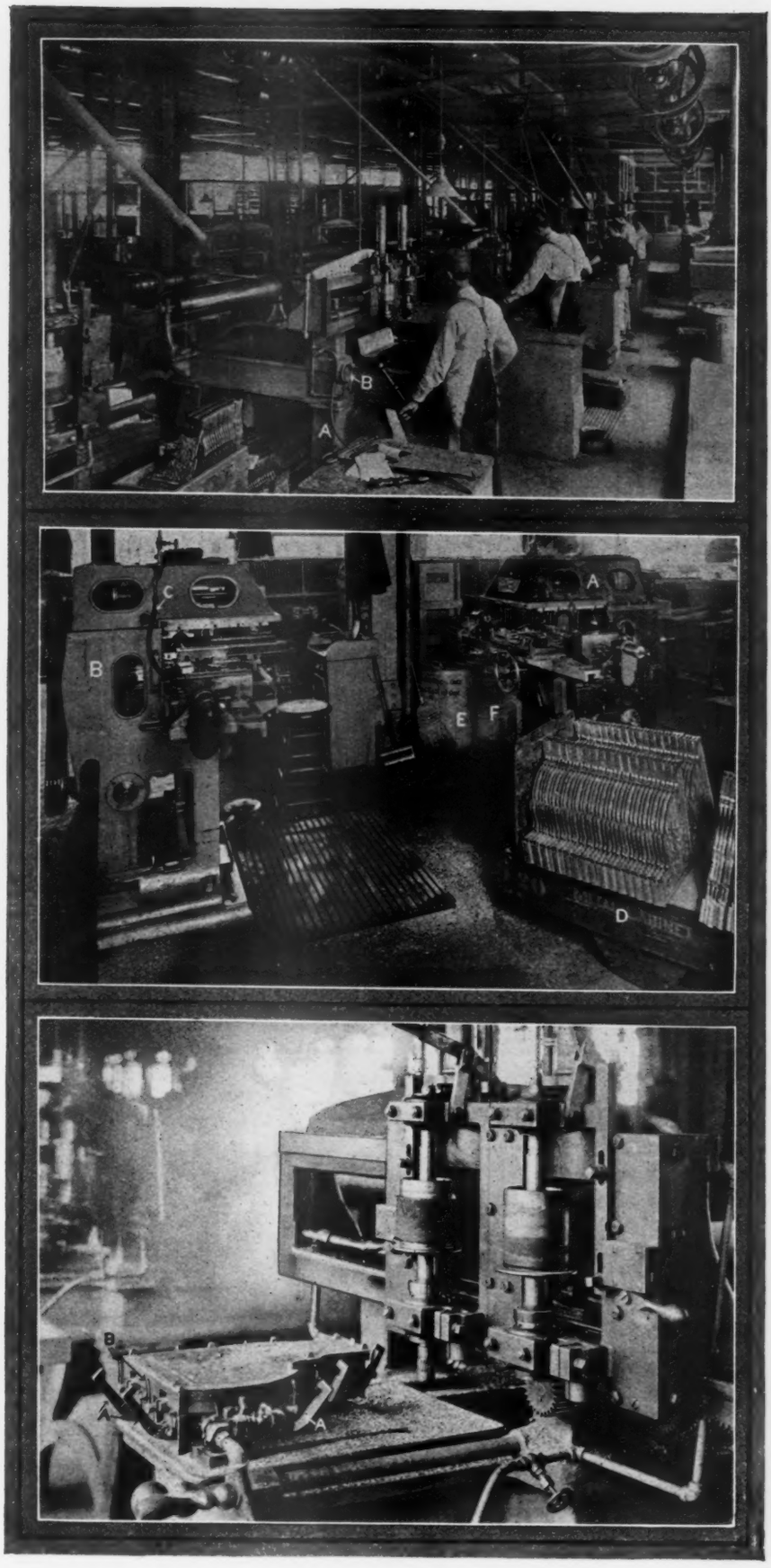


FIG. 5—A SECTION OF THE MACHINE SHOP, SHOWING PROFILING MACHINES

FIG. 6—MULTIPLE DRILLING MACHINES

FIG. 7—A VIEW OF ONE OF THE PROFILING MACHINES, SHOWING THE FINGERS RELEASED

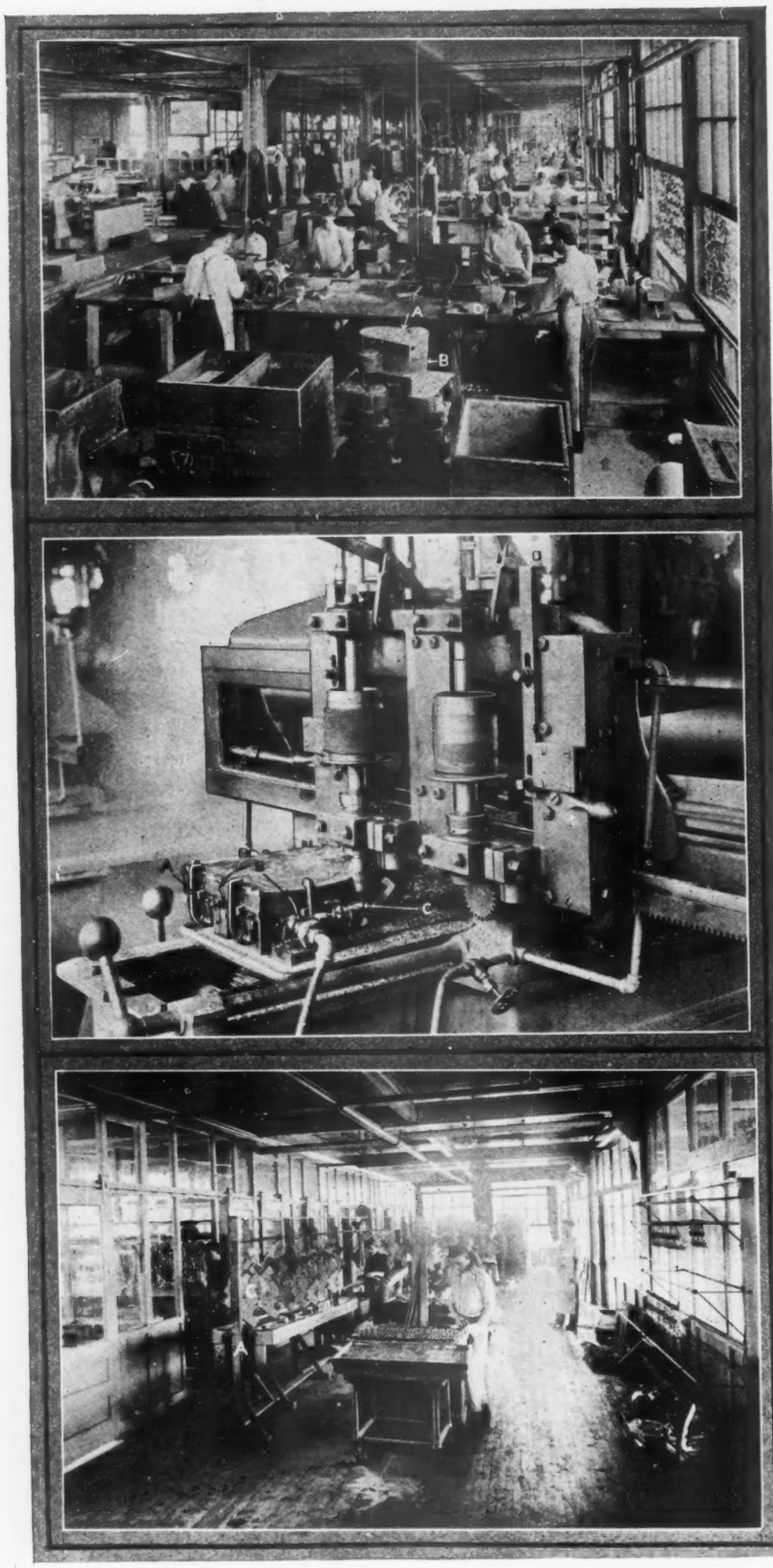


FIG. 8—GENERAL VIEW OF THE SOLDERING DEPARTMENT

FIG. 9—VIEW OF ONE OF THE PROFILING MACHINES, SHOWING THE CUTTER PASSING ONE OF THE FINGERS

FIG. 10—GENERAL VIEW OF THE LACQUERING ROOM

brass shapes could not be permitted. Therefore, the set screws had to be close together all around the outline, so that quite a number were required, and by far the greater part of the working time was consumed in manipulating the screws to secure and remove the work. This increased the expense of this operation to such an extent that other means of securing the castings were sought and compressed air was tried and a method of application perfected, which resulted in the cutting of four pieces with the air, during the time one was cut, using the set screws.

Clamping the Cabinet Parts.

It will be noted that the air is connected by flexible tubing, as shown at *A*, Fig. 5, and each machine is equipped with a pressure gage, *B*. The action of the air is instantaneous, a cabinet section being dropped onto the fixture, and upon admitting the air, it is rigidly attached, its release being as easily accomplished. With some sections, however, two operations, each using a different fixture, were necessary to cut all sides of the castings, which practically doubled the cost of the machine work, and to overcome this difficulty, the fixture, shown in Figs. 7 and 9, was devised. Fig. 7 shows a cabinet side in position on the fixture, which, it will be noted, is provided with fingers, *AA*, similar to clamps, hinged to the base of the fixture. When the air is admitted, these clamps spring to the position shown in Fig. 9, and at the same time exert a downward compressive movement, which firmly clamps the casting to the jig. In Fig. 9, the machine is shown in operation, and illustrates the manner in which the cutter passes the clamps. The cutter is traveling from left to right so that it has already cut the opposite side and visible end and has proceeded to the front, to the position shown, in its passage. Just previous to reaching one of the fingers, it encounters the triggers, *B*, Figs. 7 and 9. Each clamp has its own trigger, and the cutter in its progress depresses it, as shown at *C*, Fig. 9. This shuts off the air from that particular clamp and the springs at its base immediately release it, permitting the passage of the cutter. During this time the cutter is depressing the trigger, but having passed the clamp, it also reaches the end of the trigger, which slides off, and springs back into position, admitting the air, so that the clamp immediately resumes its position of holding down the plate. By this ingenious arrangement the sides are finished in one operation, resulting in a saving of more than half the former cost.

The next operation, after the profiling, is the drilling, which completes the ma-

chine work. A view of two of the multiple-drilling machines, manufactured by the National Automatic Tool Co., Dayton, O., is shown in Fig. 6. These machines drill all the holes required in a particular part in one operation, both vertical and horizontal, the average number of holes being 25, although they are equipped to drill several times as many. The machine at the right, *A*, Fig. 6, shows the fixture in position, ready to drill a cabinet side. The castings are clamped to the fixtures by compressed air, as in the case of the profiling machines, the connection being shown at *C*, Fig. 6. The manner in which the castings are handled in this department may be seen at *D*, which shows one of the trucks loaded with cabinet sides. As different alloys are used for making these cabinets, some system had to be devised of keeping the chips separate, so that the bronze, yellow brass and german silver would not become mixed, which would increase the difficulty of their disposal in the brass foundry without affecting the color of the other castings. The cans shown at *E* and *F*, were adopted, *E* being lettered for bronze chips only, and *F* for yellow brass. It was found, however, that providing these receptacles did not insure the chips being kept separate, so a premium system of giving credit was adopted, mixed chips being credited at 5 cents per pound to the department producing them, while for separate and clean chips, 15 cents is allowed. As a spirit of friendly competition exists, which makes each department anxious to make the best showing, this scheme had the desired effect, and the chips are kept carefully separate.

The finishing or machine room of the metal cabinet department is 520 x 60 feet and employs 200 men, handling about 150,000 pounds of bronze weekly. After the operations of the machine department, the cabinet sections are returned to raw brass stock as parts, from which they are requisitioned as orders require and are issued to the polishing and plating department for the final finish. They are now no longer parts, but are issued as knocked-down cabinets, some of which are rough-assembled. The parts comprising each cabinet are now kept together with an identification tag in separate drawers, in cases shown at *A*, Fig. 11.

Dipping Room.

The next stage of the journey of these castings through the shops is the dipping room, Fig. 2, where the new parts are bright-dipped, and after leaving the acid, they are washed in cold water, then in hot water and are dried in sawdust. Old castings from returned machines, of which a large number are

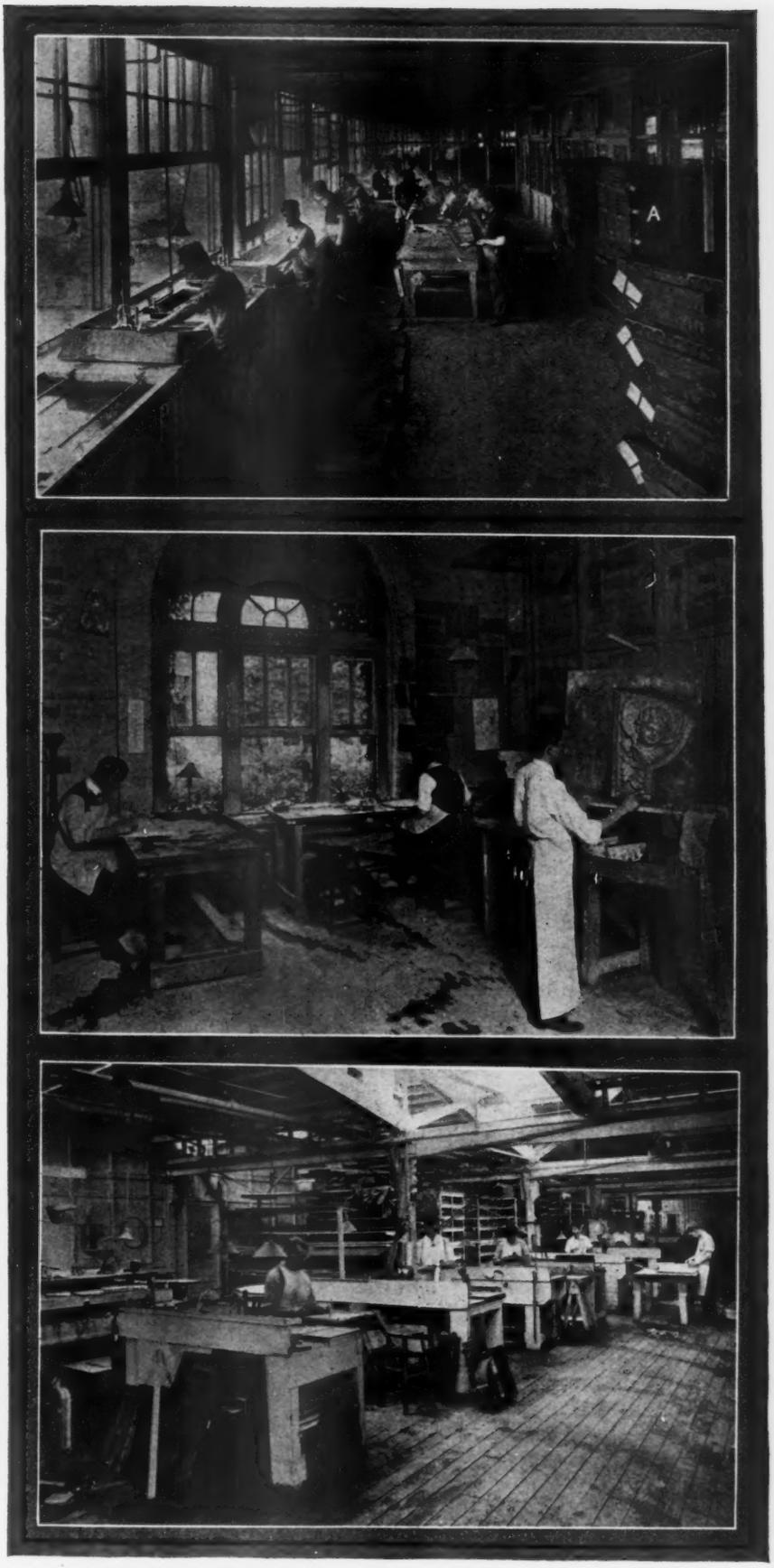


FIG. 11—WASH ROOM OF THE LACQUERING DEPARTMENT

FIG. 12—THE MODELING ROOM

FIG. 13—WOOD-WORKING DEPARTMENT OF THE PATTERN SHOP

FIG. 14—CHASING AND METAL PATTERN DEPARTMENT

received in exchange for larger or more modern machines, are stripped before going into the bright dip. Some of these old castings may be nickel-plated, and some oxidized, and this coating is removed by dipping in a mixture of nitric acid and oil of vitriol. This is practically the same as the bright dip, only the latter is maintained a little sharper than the stripping dip. The stripping operation is conducted with such care that the castings require no repolishing, but are delivered immediately to the buffing wheels after leaving the dipping room. The precipitate which gathers at the bottom of the stripping jars, and which consists of salts of nickel, copper, zinc, etc., is thrown away, as it has been found it does not pay to recover the metal therefrom. It will be noted that the fumes of the dipping solutions are drawn away by hoods over each tank, which are so effective that there is very little odor in the room. The various dips are contained in earthen crocks, *A*, Fig. 2, which are surrounded by the hot water contained in the wooden tank, the sawdust bench being shown at *B*. The next operation is scratch-brushing, after which the parts are polished. The polishing wheels are on the opposite side of the room from the grinding wheels shown in Fig. 4, the appearance of the wheels and the method of polishing being very similar to that of the grinding, no illustration is presented of this department.

Washing the Castings.

After being polished, the castings are buffed, and from the buffing wheels they are delivered to the wash room, where all the dirt is washed off to prepare for the lacquering. The work is first cleansed by washing it in warm, soapy water, made with common, yellow soap, and as the grease sticks in the crevices of the ornamental scroll work, it is necessary to scrub it vigorously with brushes, the castings meanwhile being supported on skids, at one end of the tank, as shown in Fig. 11. After the casting is thoroughly cleaned in the soapy water, it is rinsed in cold water and then passed through a solution of cyanide of potassium to remove stains. It is then passed through a weak muriatic acid pickle to kill any cyanide, as the latter gets in the pores and afterwards spots-out, making brown discolorations, as acid never causes stains, spotting being due to alkali retained in the pores. After the acid dip, the work is re-rinsed in cold water, then in hot, and dried in sawdust, and if the finish is natural bronze, the parts are sent to the lacquering room.

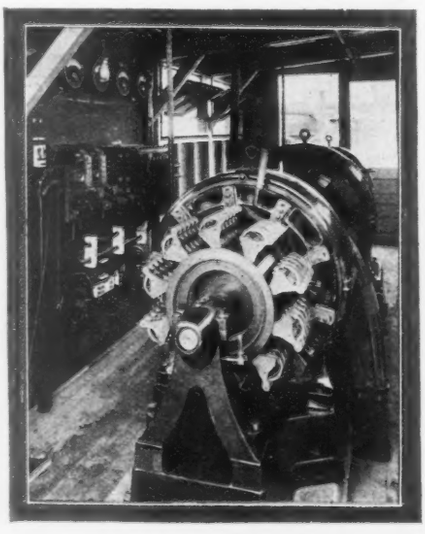


FIG. 15—ONE OF THE GENERATOR UNITS FOR THE PLATING DEPARTMENT

Various Finishes.

The various finishes include nickel-plate, natural bronze finish, oxidized bronze finish, the various copper and silver oxidized finishes and other especial finishes that may be demanded by customers. After the washing operation, the various cabinet parts, which are to be plated, are sent to their respective plating jobs, and afterward, if nickel-plated, are given a final color or air-buffing. They must then be rewashed to remove the coloring dirt from the ground, and are then delivered to finished stock. If the cabinet has an oxidized finish after copper or silver-plating, as the case may be, it is relieved by buffing to form a contrast between the parts oxidized and the natural color of the metal, then rewashed, lacquered and sent to finished stock.

Plating the Castings.

Fig. 1 is a general view of the plating room, and most of the tanks shown contain nickel solutions. Each tank is equipped with an indicator rheostat, volt meter and ampere meter, thus insuring absolute control of current at all times. The voltage is kept at 1.7 volts for the

nickel and silver-plating solutions, and for iron castings it averages from 2 to 2.25 volts. At present, the solutions are not agitated and the low voltage used has been found to give more certain results, although slow. The introduction of compressed air is contemplated, however, to agitate the solutions, which will permit the use of a higher voltage, giving more rapid work of the same quality as turned out at present.

Fig. 3 is a view of one end of the plating room, where the silver-plating and jobbing work is done. The generators, Fig. 15, are located on the roof of the metal cabinet building and are separately housed, each containing one unit consisting of a motor and two generators, of a current capacity of 11,300 amperes at from 6 to 12 volts.

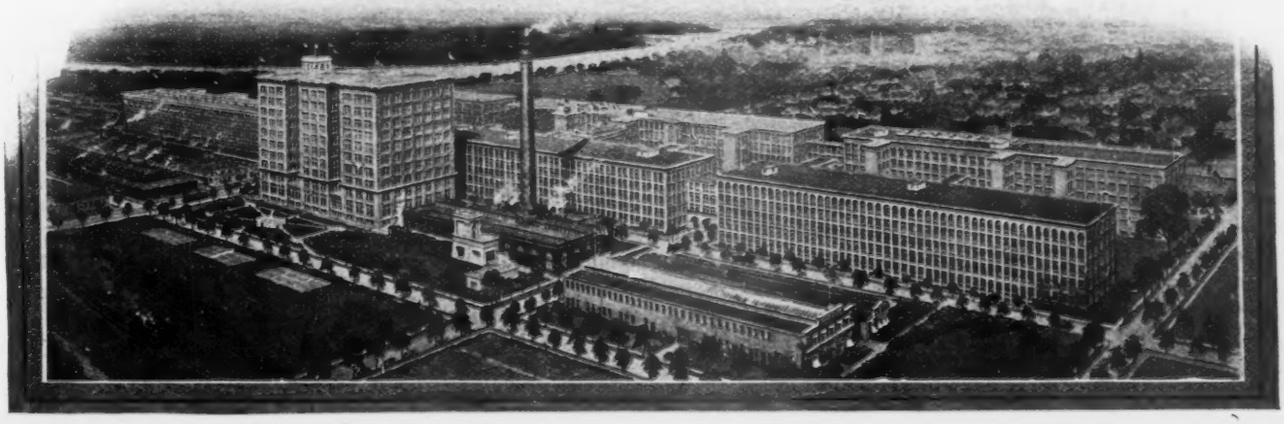
A view of the lacquering room is illustrated in Fig. 10. The drying ovens are shown at the left, and the room at the right is the lacquer wash room; *A*, Fig. 10, is one of the lacquering tanks with drip trays. The tank is situated between two trays, which are inclined so that the drippings will run back to the tank. The work is all lacquered by dipping and is then hung up, as shown at *C*, to drip.

The drying ovens, which are largely formed of glass partitions, are maintained at a temperature of about 170 degrees Fahr., and when the work has ceased to drip, it is placed in the ovens, where it is allowed to remain over night to harden the lacquer, which improves the wearing qualities. During this, and all previous operations in the plating department, the several parts of each cabinet must be kept together and must always be accompanied by the identification tag, which, during the lacquering process, is held in a clip formed on the hooks by which the sides are suspended. The drying process completes the series of operations and the cabinet parts are placed into the furnished stock storage, from which they are drawn as required and fitted onto the particular machine for which they are intended. All the cabinets, from the rough assembling to the final lacquering, are subjected to an inspection after each operation.

Fig. 8 is a view of the soldering department, where the hoods that cover the detail strip and check-printing mechanism of the cash register, are fitted together. These are occasionally made of cast bronze, but generally the sides only, *A*, Fig. 8, are cast, the curved portion, *B*, being formed of sheet brass, and is attached to the sides by soldering. This operation is one of considerable delicacy. The solder is applied inside of the hood, and must not be permitted to ooze through the joint and appear outside, as it would show black after the hood is dipped. This is avoided by skillful handling of the soldering iron, so that while the solder is heated sufficiently to form a strong connection, it is not allowed to become fluid enough to run through to the other side. The soldering irons are heated by gas, as shown at *C*, Fig. 8, and the cast iron templates, *D*, are used to insure uniformity of curvature.

A view of the pattern shop, showing the chasing and metal pattern department, is shown in Fig. 14. The greatest care is exercised to obtain perfect metal patterns, and seven chasers are steadily employed to relieve the ornamental scroll work on new patterns. Fig. 13 shows the wood-working section of the pattern shop, and Fig. 12 is the modeling room. The patterns are first modeled in wax, or composite clay, and are next reproduced in plaster of paris. After being touched-up, they are delivered to the foundry and are cast in bronze. Sometimes the modeling is done in wax on a metal pattern, and the casting made direct from the wax. This is possible only when the outline of the pattern is not changed. Usually, the metal pattern is made from the plaster block, which is merely a slab of plaster with the pattern in relief, and it is necessary to adopt some system of thickness molding in order to get a casting.

A method sometimes adopted in such cases is to bed the plaster block in a cope, which will fit a set of interchangeable flasks, keeping the surface of the plaster block level with the joint of this match, the modeled pattern standing above the joint, the same as any pattern, when laid on a match. The nowel of a flask is then placed on and rammed up, lifted off, and laid aside. This contains the imprint of the pattern after the pattern is drawn. A second nowel is then rammed off the match, containing the plaster block, but thickness strips are first inserted between the joints of the match and the nowel. These strips are of the same thickness as the intended pattern. This second nowel, when lifted off, is rolled over, and the parting made level with the flask joint. This nowel also contains an imprint of the plaster cast, but it is not as deep as the first drag by the amount of thickness of the strips placed between its joint and the match. This impression is then well dusted with a good parting, and a cope rammed off, sand to sand. When this cope is closed over the first nowel, a space is left between the two sand surfaces equal to the thickness of the strips. This method correctly spaces the flat surfaces, and the only points which will cut through are the perpendicular surfaces, which must be shaved off in the cope, to provide the necessary metal thickness.



SWEDISH MALLEABLE IRON PRACTICE*

Development of this branch of the foundry industry in Sweden --- Adoption of the American annealing process and use of the open-hearth furnace for melting

By G. A. Blume

AT PRESENT there are in the United States and Canada about 175 malleable iron foundries, and the annual output from these plants is figured at more than 1,000,000 tons, of which about 650,000 tons are for railroad work and the majority of the remainder is for agricultural machinery. The balance is pipe fittings, hardware and general machinery parts, among the latter being parts for automobiles, for which use the material plays an important part. The industry has thus assumed a magnitude, both as regards quantity and value, which gives it a very prominent position in the industrial world. The origin of the production of malleable iron castings is of older date in Europe than in the United States, but how has this important industry developed in the old world in comparison to the records made in America? I am sorry to state that Europe in this case, as in so many others, has been left behind.

History of Malleable Iron in Europe.

As far as I have been able to learn it was in Belgium where the earliest development took place, and it was in that country that the use of malleable cast iron came into use at an earlier date than in most of the other European countries. From Belgium the art came into France and even to Germany. England has two different records covering the development of its malleable cast iron industry, one dating back to about 1800, when Samuel Lucas was granted a patent for the annealing process, and one of later date when the American blackheart process was introduced in England. In Russia very little malleable cast iron is being made, and what is made is manufactured principally by Germans in the Baltic provinces.

In Scandinavia, that is, Sweden, Norway, Denmark, and Finland, the use of malleable cast iron was practically unknown up to about 1876 or 1880, when a small foundry was started in the vicinity of Stockholm. Later, other small foundries were built in Copenhagen and Christiania as well as in a few additional cities in Sweden. Several years ago a small foundry was started at Jakobsstad, Finland. The total annual output in Scandinavia up to 1906 may be put at about 500 tons—not a very great figure if it is borne in mind that Sweden alone, should it use malleable cast iron in the same proportion to population as is the case in the United States of America, would place on the market not less than about 70,000 tons a year.

Output of European Foundries.

Regarding the yearly output of other European countries, I need only say that as a rule, the foundries in Europe are very small, if exception be made in the case of a few German foundries in Westphalia and near the Swiss border, and a few English shops. Furthermore, most of the small European foundries employ the Reaumur system and melt in crucibles, while the larger plants employ cupolas or air furnaces, and in at least two places cupola melting in conjunction with a Tropenas converter. I think that I am right in stating that in England, most of the malleable iron foundries are small, using the Reaumur system and melting in crucibles, while the few larger foundries generally melt in air furnaces and anneal according to the blackheart or American system.

European and American Process.

For those who are not conversant with the making of malleable cast iron, I will briefly explain the difference between the Reaumur and the American systems, which lies in the annealing process. The former system employs a more highly oxidizing packing or annealing medium, mostly pulverized hematite ore, and anneals at a higher temperature and for longer time, the exact period depending upon the nature of the ore. The latter system utilizes as packing mostly hammer scale or scale from the steel rolling mills. But other packings are also used in annealing according to this process, as for instance, the slag which, during melting in air furnaces, is skimmed off the bath and afterward pulverized. The blackheart process allows annealing to take place at a lower temperature than the Reaumur process, while the operations are stopped sooner, and consequently can be performed quicker.

Comparison of Results.

A comparison of the results of the two processes shows in the former case a steely fracture with a homogeneous crystallization all through, and in the latter case a black colored fracture with a lighter, grayish rim all round the edges. In one case the annealing process is carried on until most of the carbon has gone out of the iron, bringing it nearer to wrought iron. In the other, the process is stopped when only the skin of the casting is decarburized, while the carbon towards the interior of the casting is changed from its combined state in the hard casting to a new kind of amorphous carbon called "temper" carbon, which analyzes as graphitic carbon, but which still gives to the casting a certain degree of malleability.

Regarding the uses of the two different systems of producing malleable cast iron, I wish to give as my opinion that it is not right to condemn the one and praise the other, as I believe both have their applications. For castings which have not to be machined to any extent other than drilling or tapping, and furthermore have only to be painted, galvanized or otherwise coated, or for castings for general railroad work, for agricultural machinery, for boat fittings and other hardware, and numerous other purposes where the decarbonized surface is allowed to remain intact, I believe the blackheart process to be more suitable than the Reaumur; but, on the other hand, for castings which are to

*Read at the annual convention of the British Foundrymen's Association.

be machined or tooled to a greater extent, or for pipe fittings and similar work, I think the latter process is preferable. However, the one material cannot be said to be either better or inferior to the other.

Development in Sweden.

In 1906 we had in Sweden three malleable iron foundries, of which two melted in crucibles and annealed in hematite ore on a small scale, while the third melted in a small, open air furnace and annealed in rolling mill scale. The capacity of the first two foundries combined was about 150 to 200 tons a year, and of the third about the same tonnage. At that time the foundry in which I am interested was built. We started casting early in 1906 and made, during that year, about 350 tons. The following year we made about 750 tons, in 1908 about 1,200 tons, and in 1909, about the same quantity. At present we are making castings at the rate of about 1,500 tons a year. The foundry has a floor area of 39,000 square feet, of which the molding floor occupies 25,000 square feet, and the annealing department 5,000 square feet, the balance being allotted to cleaning, shipping, core-making, engine room, pattern shop, generator house, offices, etc.

Melting Equipment.

The melting equipment consists of two air furnaces, one of which is always kept in reserve for repairs, and a cupola for the making of annealing pots. The annealing department has five furnaces, of which four are built for direct coal-firing and one is heated with producer gas. In the construction of the annealing furnaces, which to a large extent has been done in the course of the development of the business, I have employed different flue systems, in order to ascertain which would be most suitable. Thus, the first two ovens have only one flue, which extends under the oven floor forward and backward some six or eight times until it finally, through one single opening, leads into the stack. When building the next two furnaces, I went to the other extreme, each flue extending direct from the front end of the furnace, under the floor to the back and into the stack. When constructing the fifth and last oven I employed still another system. The flues in this case do not run lengthwise under the floor, but crosswise and each flue has but one bend. The flues thus extend in two lengths under the floor before passing out through a damper into the main chimney flue. There are consequently, eight rows of flues under the oven floor, but only four dampers over the four flues, which extend outside of oven to the stack.

Molding Equipment.

The molding equipment is made up almost entirely of molding machines and molding presses, the greater part according to American methods. For the general run of jobbing work we usually use gated patterns (at least when any considerable numbers are ordered at one time), made of metal, either brass or other suitable pattern metals, or even aluminum for heavier patterns. For standard work, the patterns are generally mounted on iron plates and these are fitted on machines, as for instance, patterns for pipe fittings, which are mostly mounted for molding on a Berkshire automatic molding machine and on molding presses with flask-lifting devices. The gating of patterns is done in the customary way, and of late I have introduced a gating system by which the runners are attached to a light aluminum frame to which is screwed an air vibrator. On most of our molding presses equipped with flask-lifting devices, the rapping is done through vibrators attached to the molding machine itself. For deep patterns with straight draft we mostly use machines by which the pattern, through a simple lever movement, is raised from the mold. In these machines the cope and drag parts are molded from patterns attached to the two sides of a heavy iron plate, which turns on trunnions. The patterns for these machines are frequently made of plaster of paris. In general, the matches for gated patterns are made in hard sand from a mixture of some old and new sand, together with linseed oil. We never use litharge in the mixture.

Other Departments.

The equipment for cleaning castings comprises tumblers, large and small, fans and sand-blasting apparatus. Throughout the whole plant are laid pipe lines for compressed air, which is used for the rapping of the patterns while molding, for cleaning patterns and plates, and for sand-sifting. The power is all electric, and is furnished to individual motors in all the different departments throughout the plant.

The melting, which is usually done twice a day, takes four hours for a heat of about six tons, including the time required for tapping, and the coal consumed averages about one pound to two pounds of iron, although we have at times attained figures as good as 1 to 3. Our coal is best South Yorkshire, and costs, at present, delivered at the works, about £1 a ton.

The annealing is done by the American process at about 740 degrees Cent., and this temperature is maintained for about 72 hours. The coal consumption for this annealing is, in the older furnaces, ½ pound per pound of iron annealed. In the gas-fired furnace and in the furnace No. 5 previously referred to, the coal consumption is about 1/3 pound to 1 pound of iron annealed. For the Reaumur iron, principally pipe fittings, we keep the annealing temperature at about 810 to 830 degrees Cent. for a period of about 120 hours, at full heat. As packing material for these castings we use Belgian hematite ore.

Iron Mixture.

The iron mixture which we generally use for malleable casting purposes is made up of about 14 per cent West Cumberland hematite iron, 40 per cent Swedish charcoal iron, and 46 per cent of white scrap. The figures naturally vary according to the class of castings to be made. It is to be noted that we never use white pig iron in the mixture, only gray pig iron, together with our own white scrap, made up of gates, sprues and discarded castings. As to the analyses of our mixtures, they are about as follows: For heavy work (about ⅜ inch or more), silicon, 0.60 to 0.70 per cent; phosphorus, 0.05 per cent; manganese, 0.14 per cent; silicon, 0.03 per cent and total carbon about 2.85 to 3.10 per cent. For lighter sections the silicon is often run up to 1 per cent or 1.10 per cent.

The iron is poured very hot, usually, at a temperature of about 1,470 degrees Cent., and is carried by the molders themselves to their molding floors in small hand ladles holding from 40 to 60 pounds each.

Labor.

Although the general complaint among the Swedish manufacturers is that the Swedish laborer does not give the average daily output of a good workman, at our works we have succeeded quite well in this respect, at least in our malleable iron foundry. One hundred molds a day, 14 by 16 inches, in addition to the laying of cores, are common on regular squeezer work, and on special ma-

chines the output is frequently a great deal more. The piecework system prevails, including molders, floor hands, cleaners, coremakers, annealers and others. The melters and firemen are paid by the week or month.

I might say, furthermore, that we, after a recent strike in our coremaking department, started to employ girls as coremakers and now we have only a small number of boys for heavier cores. The class of goods that we make is principally for agricultural machinery, for railroad cars, pipe fittings, boot hardware, together with hardware of all kinds and machinery parts in general.

Cost of Production.

As regards costs, I take it that it will interest the English makers of malleable castings to learn what results others in that respect are doing. Converting our coinage and weights into English equivalents, I may mention that in our town we pay for common labor in general, 3s 4d a day for ten hours' work, and to skilled molders from 4s to 5s a day. The machine molders we cannot put in the same class with the bench and floor hands, but at first they receive the wages of common laborers. With iron at £4 14s 5d a ton and coal at £1 a ton, our average cost per pound of finished goods is 2d, including general expenses and depreciation on buildings and machinery. How these figures compare with English conditions I do not know. That they compare very favorably with the other makers of malleable castings in Sweden and the other Scandinavian countries is, on the other hand, certain, although I am very well aware that, as yet, we have not, by far, reached the figures which we are aiming at. Especially will this be noted when we compare the figures mentioned with those of the large American foundries. At least one Chicago foundry is making malleable iron castings for agricultural machinery at a shop cost of 2¼ cents per pound, or about 1⅛d, or not much more than one-half of the foundry cost which I must figure upon in my works.

Quality of Output.

I shall later revert to the manufacturing costs of my castings and the results of my efforts to reduce these costs. Before referring to this, however, a brief account of the system of control of the quality of castings which we are employing at our works will be given. As is well known, it is very often claimed that the quality of malleable iron castings generally is not sufficiently uniform. A customer will sometimes say that one shipment of castings is not as good as another, or sometimes claims are made that deliveries must be rejected on account of poor quality. Many engineers with whom I have talked about malleable castings in order to induce them to use that class of iron ware to a greater extent, have answered that their experience with that class of material has not been altogether satisfactory. While some foundries have sent them samples showing a high degree of malleability and softness, the castings eventually ordered and delivered have been poor. This has forced me to develop a system of control which should enable the foundry to always guarantee a homogeneous quality. A short explanation of this system will probably be of some interest.

Tests.

All irons are bought according to analysis, and all carloads received are analyzed by the laboratory to learn how closely the specified analysis is followed. The mixtures are made up according to analysis, and the iron of every melt is analyzed daily. From every heat we take samples, partly in heavy blocks about 3½ inches square, partly in round test plugs about 1¼ inches diameter, and finally in wedge-shaped test bars 6 inches long, 1 inch wide and with the thickness tapering from ⅝ to 1/16 inch. All test pieces are marked with the date and number of heat and can thus be easily identified. The square and round bars are kept un-annealed as a record of the fracture of the iron in the hard state, and the wedge bars are packed together with castings from the same heat of which the bars are samples. After annealing, these test bars are hammered and made to curve up from the thin end; the distance from the base at which fracture takes place determines the quality of the iron. From a certain number of heats tests are also made to determine the tensile strength.

To control and record the firing of and temperature in the annealing ovens, we use recording pyrometers. By comparing, after each anneal, the analyses of iron in the charge and of the iron melted with the fractures of the hard test pieces, and the testing of the wedge bars with reference to the length and height of the heating in the annealing ovens, we have a fairly good record of the material from its origin to the final result, with all the important phases of the manufacturing process noted.

Construction of Air Furnaces.

It has always seemed wrong to me that so much fuel and heat should be wasted in the melting of iron, as is the case in air furnaces, and I have studied the construction of these furnaces very carefully. We have frequently changed our furnaces in form and general design; we have tried to preheat the blast; we melted with a high blast pressure and with low pressure; we have carefully gone into the question of taking care of at least some part of the waste stack heat, either for heating or for power, and still, although something had been gained, the cost of melting was far too excessive. I, therefore, turned my attention to open-hearth furnaces, which I knew were being used in a few foundries in America. The reports I was able to get from the States were, however, not altogether satisfactory, as it seemed necessary to have the hearths very large and to run continually day and night in order to get economical results. But I did not feel satisfied to let this matter drop, as I did not quite see why the open-hearth furnace, or some modification thereof, could not be used to advantage in obtaining quicker melting with less oxidation, and cheaper melting by a saving in fuel and labor.

Open-Hearth Furnace.

However, it seemed evident that a conclusive answer to these questions could not be obtained without trial. I therefore made arrangements with a friend who was running a steel mill and who had on open-hearth furnace of the very latest design, whereby I obtained the right to use the furnace for a time during which I was to make all the experiments necessary to determine my future course. The results of these trial meltings were in every respect splendid proof of the suitability of the open-hearth furnace for malleable casting purposes. I found that a 3-ton charge could be charged, melted and tapped in less than two hours—in fact, for one heat these operations only required 1½ hours. The saving in fuel was great, and averaged 18 per cent of the weight of the iron produced. At one time a heat of 3 tons was made with a fuel consumption of less than 350 pounds of coal. Instead of, as in melting in air furnaces, requiring one melter and at least one man to handle the slag, the melting in the open-hearth re-

quired but one man, the melter; no skimming of the bath was needed, and the firing of the gas generators was combined with other labor. The iron can be quickly overheated, so that the whole charge of 3 tons is tapped into one ladle, and from this to smaller hand ladles in different parts of the foundry, where it was cast without short-pouring.

Repairs.

Finally, as regards furnace repairs, I may say that the open-hearth furnace, which I used, was operated more than 10 months steadily without repairs, and I am confident that repairing once a year is all that would be necessary with an open-hearth furnace run for iron melting. I also made extensive experiments to learn whether this type of furnace could be used, even if the melting were not continuous day and night. I found that the furnace could very well be closed and the dampers shut without firing and without the furnace losing too much of its heat during the night; on Sundays it could be kept warm by using a very small quantity of gas and blast.

The iron used during the experimental meltings mentioned was all Swedish charcoal analyzing as follows: Silicon, 0.70 per cent; phosphorus, 0.09 per cent; manganese, 0.04 per cent; and sulphur, 0.015 per cent. But poorer irons were also used, although they required some refining, and consequently a longer time in melting, still gave equally good results as regards strength. The loss of silicon through oxidation during melting was practically none, and the control of the flame was perfect during the whole of the melting operation. A lot of the castings from the open-hearth heats were later annealed, both in ore and in shale, with equally good results.

As a result of my experience with the present plant, together with the use of producer gas for annealing, and also from the experimental meltings in the open-hearth furnace, I am satisfied that malleable cast iron, of the variety which is being made at our works, can be produced in Sweden at a cost very much lower than at present, or about 1½d a pound. As alterations to our present plant to include all the desired improvements would involve such radical changes that practically the whole plant would have to be torn down, we have decided to build an entirely new foundry, embodying all such improvements as are deemed practical.

Inartistic Fillets---How to Avoid Them

By Darby O'Quill

PERFECTION of outline in castings is something worth striving for, and there are several firms throughout the country that insist on its accomplishment. This is nothing more than we ought to expect, although indeed, it is in many instances well nigh impossible of attainment. The chief obstacles to this progressive and very necessary movement are the molders themselves, many of whom do not know how to use the tools necessary to attain the object sought, nor is their artistic sense highly enough developed to appreciate the nicely finished lines of a perfect mold. What they cannot do with the hand, trowel, ordinary double enter or Yankee slicker, swab or camel hair brush, has to go undone. Those best acquainted with the lot of the molder, know that it is at best a pretty hard one, and it is not my desire to add to his trials, but he could often make himself better appreciated if he made a greater effort to eliminate the many crudities that attach themselves with barnacle-like tendency to his everyday work.

Lack of Time.

I have heard molders claim, when upbraided for unskillfully made fillets, which are such an eye-sore on otherwise good castings, that they did not have time. Such an excuse is absurd as the thing can be done right in less time than it takes to do it wrong, provided the proper tools are provided. There are certain parts of the country where the artistic use of proper finishing tools is extensively employed, and where the molders vie with each other in endeavoring to do the neatest job of finishing, and in owning the most complete set of tools. Theoretically, the use of these special tools ought to be learned rapidly, but unfortunately in practice the opposite is found to be true, unless the molder was brought up to such things in his apprenticeship days.

Proper Tools.

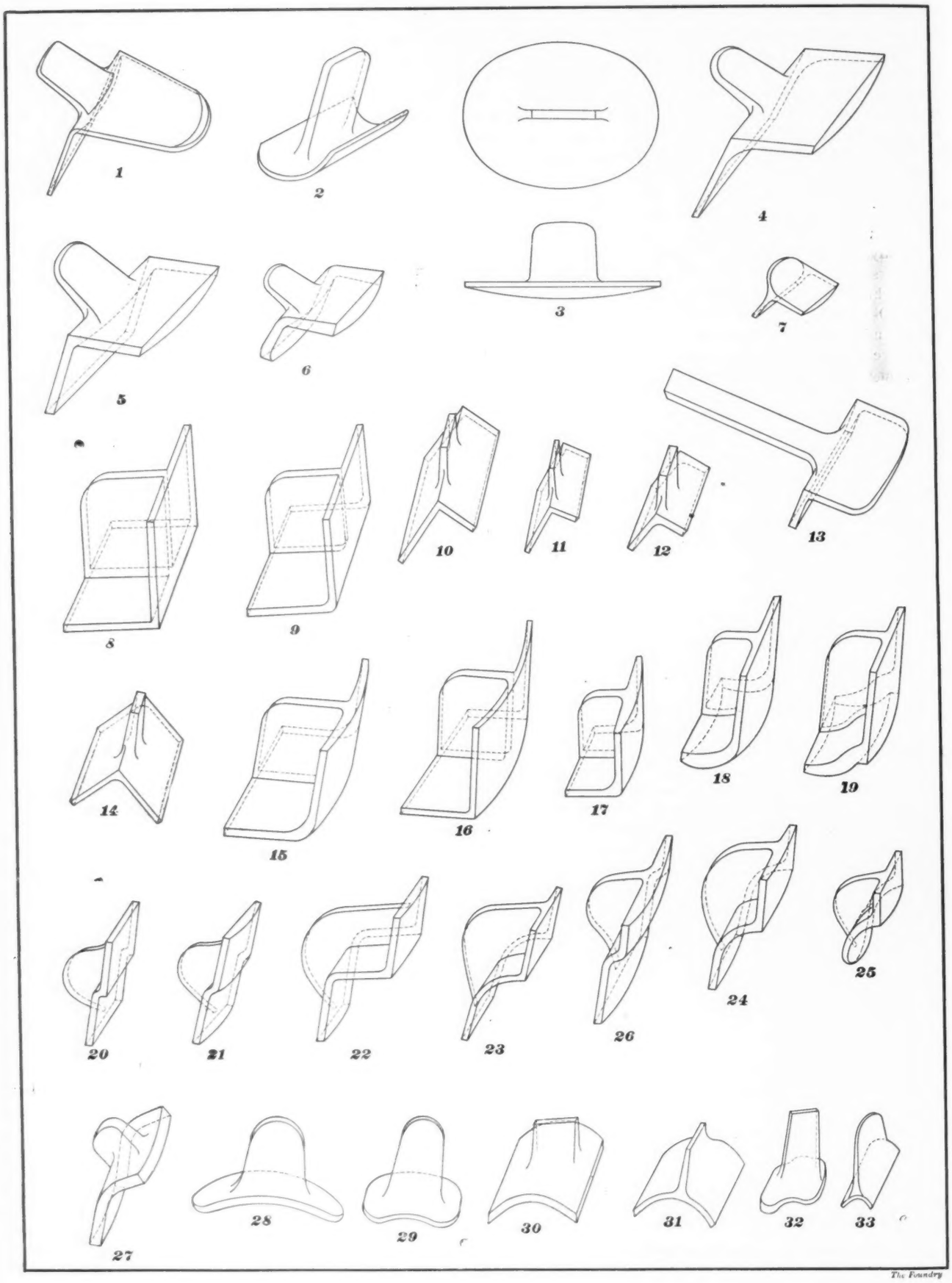
With the exception perhaps of the segmental corner tool, the button tool, and the pipe slick, such tools are altogether unknown in most parts of the country. The most common are the joint and edge tools, core print tools, check tools of various sizes, fillet tools of different and varying radii, various styles of flange slicks that are attachable to long handles for deep work, dozens of shapers that are well nigh nameless, and many specials for special jobs.

Special Tools.

Occasionally a job is given a molder with some filigree work on it, which no tool in his kit will fit properly. If he is one of those who prides himself on beautifully finished work, he proceeds at once to make one. This is how he usually does it. He takes a piece of soft clay and takes the impression of the part he wants from the pattern, dries it, and when done presses another soft piece of clay into it, drying that also. He then has, so to speak, a cope and drag, and he puts the desired thickness of clay between them, secures his mold and probably puts it in his pocket. When at home, in the quiet of his own fireside, he casts it with lead, probably melted in the frying pan. He then dresses this for a pattern, and if he cannot take time himself, he gets his friend, the bench molder, to cast one for him in iron, though if possible for him to get it, he usually prefers brass. With a little filing and rubbing-up he has a tool made specially for the job and the result is a perfectly outlined surface on the casting.

Some molders would never think of doing a thing of this kind, for what is left in the way of artistic touches after the application of the common tools, remains undone, in all probability to remain an unsightly botch, on what might have been, with a little trouble and a due regard for the proper fitness of things, a perfect job and a joy to look upon.

Much of the above is more particularly applicable to large work



MOLDERS' TOOLS, WHICH MIGHT BE TERMED "SPECIALS," BUT WHICH SHOULD BE INCLUDED IN EVERY MOLDER'S KIT. THEY WILL PROVE EXCEEDINGLY USEFUL FOR DRESSING MOLDS, AND THEIR USE IS A POTENT FACTOR IN THE PRODUCTION OF BEAUTIFULLY FINISHED CASTINGS

made in loam and dry sand, but a badly finished casting from a green sand mold looks just as bad or a trifle worse, is just as inexcusable and calls for just as much condemnation.

It is a disgrace to the art of molding, to see an exposed engine bed or other particular casting all painted up in good shape with a fillet on one of the supporting ribs, intended to be of ½ inch radius, and to observe that fillet varying from ½ to perhaps 1½ inches, the ups and downs of size on it being greater and rougher in proportion than an inverted section of the Rocky Mountains. The Henry R. Worthington Co., some years ago, was so insistent on this matter of proper finish and outline that it furnished a set of special tools with each job. The example had its good effects, for it is no uncommon thing to find some of the molders in that locality, having over ten pounds of well finished special tools in their possession, many of which, if they could not be easily reproduced, would be unpurchasable.

A visit to our machine shops, many of which no doubt pride themselves, and perhaps justly so, on the quality of their castings, will develop the fact to critical observers, who are not all foundrymen by any means, that here and there the nice sharp outlines of a flange are spoiled by having blacking left in the corners so as to round them; that fillets behind the flanges are not of the same radius all around, and perhaps deeply pitted from nail heads which the molder failed to properly drive home when finishing the job. True, the patternmaker, in his paternal spirit, may have neglected to put a leather fillet there, or the pattern may not have drawn as well as it should, but such are poor excuses for molders making such botch jobs as long as there are tools for the purpose which they should own and know how to use.

The sketches on the opposite page show some of these useful tools, perhaps the most common and useful of them, and every molder worthy of being called an artist, should study them and know how to use them to the best advantage. The uses for which these tools are intended are given herewith:

No. 1.—Edge tool for use on wheels, cylinders and other round molds.

No. 2.—Ordinary pipe tool, several sizes of which are used.

No. 3.—Oval slick, used on the neck of engine beds and similar curves.

Nos. 4, 5, 6 and 7.—Print tools, used for properly shaping, edging and finishing different sizes of core prints at their junction with the mold. Nothing looks worse on a mold than a ragged core print, or other ragged edges.

Nos. 8 and 9.—Inside edge, or corner tools, one sharp and one giving a slightly rounded cover.

Nos. 10 and 11.—Edge tools for properly forming the joints of molds.

Nos. 12, 13 and 14.—Tools for making a very small fillet, the next thing to a sharp corner.

Nos. 15, 16 and 17.—Round corner tools, the use of which is fairly well known, as they are now made in different sizes by the principal makers of molders' tools.

No. 18.—Slick for round flange.

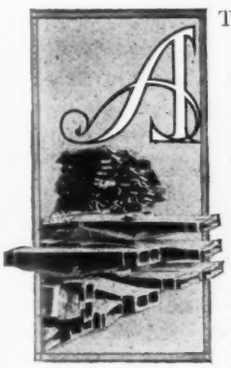
No. 19.—Slick for flange, such as is often used on air chambers and similar work. Without a special tool it is impossible to make a good job of such a flange.

Nos. 20, 21, 22, 23, 24, 25, 26 and 27.—All known as slick tools, and are very important. The smaller ones are principally used on the extra thickness over counterbores of cylinders.

Nos. 28, 29, 30, 31, 32 and 33.—All fillet tools of varying radii, the use of which are indespensable where proper curves are required.

A Modern Steel Foundry

By H. Cole Estep



AT Canton, O., is located a new steel castings foundry which is worthy of description because of the sensible economy everywhere exhibited in its construction and operation. Sensible economy is the happy medium between parsimony and useless extravagance, both of which result in increased operating expenses. Some plants are so bare of proper equipment that their work cannot be executed except at a great waste of time and labor; others are so overloaded with so-called labor saving devices that the owner grows gray headed figuring out how to meet his fixed charges. The Shull Steel Castings & Mfg. Co.'s plant, at Canton, with which this article is concerned, exhibits neither of these extremes, but is a modern sensible shop, built with a knowledge of foundry operating conditions and the possibilities of the local market.

The plant is situated in the southern part of the city at the corner of Graham avenue and Allen street, on a tract of low ground which offers an easy solution to the problem of disposing of the slag and waste materials. These are merely dumped outside the plant, so that eventually the company's entire property will be filled to the molding floor level. At present only the floor itself is filled to grade. Adjacent to the works is the main line of the Wheeling & Lake Erie Railroad, from which a spur is built convenient to the shipping and raw material storage yard. The foundry building is 127 by 240 feet in size, with the gas producer and office buildings separate. The building is of corrugated iron and glass construction and the steel columns supporting the roof are set on brick instead of concrete piers. The molding floor dimensions are approximately 60 by 240 feet.

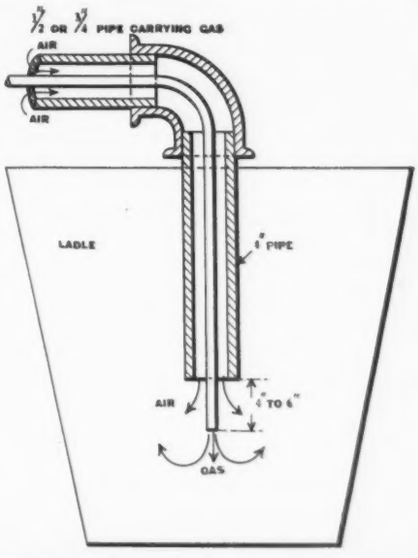


FIG. 1—GAS BURNER, AS USED FOR DRYING LADLES

The Acid Furnace.

Centrally located on one side of the floor is the 10-ton, open-hearth, gas fired, acid furnace. This furnace was built by the Amsler Engineering Co. It has three doors, counterweighted and operated by hand. Forter's Patent regenerator valves, designed and built by the Wellman-Seaver-Morgan Co., Cleveland, are installed. In all respects the furnace is standard in construction and presents no unusual features. The charging platform is ample in size, provided with scales, and is so arranged that the charges

may be handled economically. An expensive tramway, crane system, or telpherage has not been installed for bringing the material to the charging platform. Instead, a substantial wooden incline, on which are operated wide tire trucks or buggies, leads from the storage bins. This method of handling material from the bins to the furnace is at once simple and economical.

Gas Producers.

Behind the furnace is the gas producer house, of substantial brick construction, 36 by 25 feet in size. Two Amsler gas producers, 9 feet 6 inches in diameter, are installed, together with the usual pipe connections to the furnace. The producers are set low and the charging floor is about on a level with the charging platform of the furnace. The producers were built by the Morgan Engineering Co., Alliance, O. While the gas making apparatus is complete and ready to run, the furnace is at present burning natural gas obtained from the local pipe line. Natural gas is found to be freer from sulphur than that which it is possible to make in the producers, and on account of the better grade of castings produced therewith, is considered to be more economical than producer gas, as well as more convenient. The gas producer plant is merely held in readiness for emergencies.

Cranes.

All the transportation of materials, sand, ladles, etc., about the shop is effected by means of traveling cranes. No auxiliary devices are used and the crane system is unusually complete. The underlying idea in this installation is to concentrate the transportation facilities into one system so that only one set of repair parts need be kept in stock. This reduces expense, and also the delay resulting from any breakdown in the apparatus, to an absolute minimum. Four cranes, built by the Morgan Engineering Co., are installed; three are in the main bay and one in the side bay opposite the furnace. The largest main bay crane has a capacity of 15 tons and the other two of 10 tons each; the capacity of the side bay crane is 5 tons. These cranes can reach every part of the shop and enough are provided so that the molders do not have to wait for the crane.

The practice of the shop presents a few unusual features. The sand mill, which is driven by an independent 30-horsepower motor, is at one end of the shop and is elevated so that the mixed sand runs directly into a bucket, in which it is carried by a crane to the place on the floor where it is needed. Cast iron and cast steel flasks are used exclusively and have proven themselves to be more satisfactory in every way than the wooden ones. The molds are rammed hard, in many cases are nailed where a cast iron mold would be left unprotected, and usually are skin-dried or oven-dried. An interesting feature is the practice of placing baked sand pouring basins on each mold. These basins are made up separately out of solid blocks of oven dried sand, and before the copes are rammed are placed on bricks so arranged as to form a gate leading into the mold. The cope sand is then rammed around the basins and bricks, incorporating them solidly with the mold.

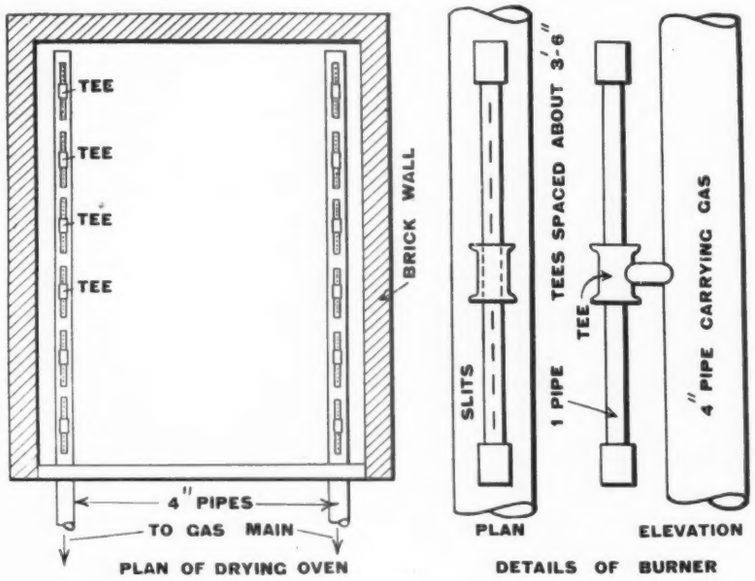


FIG. 2—GAS BURNER USED FOR HEATING THE MOLD DRYING OVEN

Heating Ladles.

The design of the gas burner used to dry out the big ladles is interesting. By experiment it was found that combustion with some burners was incomplete, and therefore the simple device illustrated in Fig. 1 was built. It consists simply of a 4-inch pipe inside of which the ½ or ¾-inch gas pipe is laid. The distinguishing feature of the device is that the gas pipe extends 4 or 6 inches out of the large pipe, which carries the air, and therefore the gas has a chance to spread and mix thoroughly with the air before burning, thus insuring complete combustion, economy and absence of soot.

Mold Drying Oven.

The mold drying oven is situated beside the furnace and contains a gas burning apparatus that is also of exceptional interest. Fig. 2 illustrates the apparatus, which consists of a 4-inch pipe run along the floor at each side of the oven. Into this pipe are screwed several 1-inch tees, capped at both ends. The tops of the tees are about 3 feet long. In them are cut a succession of slits, each about 1 inch long and from 1-32 to 3-32 inch in width. The gas coming out of these slits is lighted and burns freely with almost perfect combustion. The burners are very economical of gas and the design is in every way commendable.

The plant has the usual complete equipment of auxiliaries, including core ovens, annealing ovens, machine shop and forge shop, all of ample size and properly equipped to handle the work. Electric drive is used throughout the shop. The electrical equipment, which is installed in a separate fireproof compartment, includes a 75-horsepower motor-generator set, switchboard, motor starter and auxiliaries.

The Tabor Mfg. Co., Philadelphia, manufacturer of molding machines, saw and milling cutters, tool grinders, etc., has purchased a tract of 5½ acres on the Chestnut Hill division of the Pennsylvania railroad, which affords excellent shipping facilities over both roads. A large plant is to be erected upon this site and work will probably be started early in the fall.

THE BRASS FOUNDRY

Molding Brass Axle Bearings For Electric Cars

By C. Vickers

THE method of making axle brasses, outlined herewith, and devised by the Milwaukee Electric Railway & Light Co., Milwaukee, is not intended to compete with machine molding, but is a great advance upon the antiquated method of making these castings, one at a time, on the bench, and in addition, the rigging is inexpensive. The ancient method referred to is still in vogue in some brass foundries, the idea undoubtedly being to cast them "bearing down," under the mistaken notion that a better bearing is the result. A little reflection, however, will convince anyone, since these castings are machined all over, that it makes no practical difference how they are cast, as both sides must be equally clean.

Construction of the Bearing.

A complete bearing consists of the two halves, *A* and *B*, Fig. 2, but in order to place them in position on the axle, they must be split. This is taken advantage of in the larger sizes as it is more convenient to mold them in halves than it would be to cast them together in the form of a bushing, using a core, although this method is generally adopted with the smaller sizes of motor bearings, the cores of which do not exceed 4 inches in diameter. When cast in one piece, however, they have to be split after machining, and when cast in separate halves, the first operation in the machine shop is to plane off the joint surfaces, and solder the halves together. The patterns must, therefore, carry stock allowance for this, on the upper edges, so that when the joint is planed, the two halves will form a circle when soldered together. They are then placed in the lathe and turned up completely to size, when any porosity or other blemishes will become visible. Therefore, the castings have to be clean, and should be made of a fairly good bearing alloy. After the machining operation, they are split, and to keep them from being separated while in stock, are taped together.

The Drag Match.

It will be noted, that by this method of molding, the bearing part is lifted in the cope, and to decrease the amount of the lift as much as possible, the patterns are raised in the drag, which, of course, necessitates a sunken match, as shown in Fig. 3. To make this match, the patterns are arranged on a board so that they can be molded to the best advantage, and the drag of a flask placed over them. Before this is rammed up,

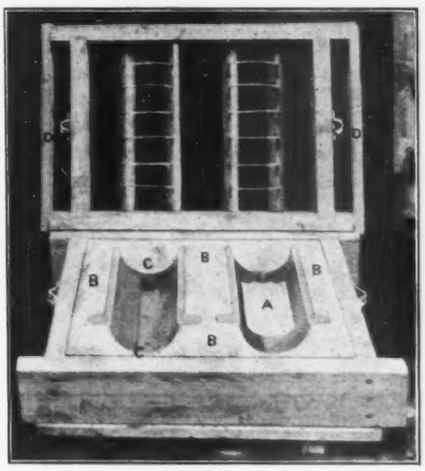


FIG. 1—DRAG HALF OF MOLD WITH THE COPE FLASK IN THE BACKGROUND

it is raised off the board by placing wooden strips between it and the flask joint, and the thickness of these strips should be equal to the height it is desired to elevate the patterns above the parting of the drag.

The drag is then rammed up and rolled over, and the parting made, as shown at *BBB*, Fig. 1, which illustrates how the sand is banked up around the patterns and sloped to the flask joint, resulting in the deepest part of the bearing being very little lower than the joint. Consequently, there is only about one-half the lift there would be if the upper edges of the patterns were level with the flask. This makes it much easier to mold, because by reducing the slopes, *CC*, Fig. 1, the chances of bad lifts are greatly reduced, as it is at these points that the sand usually sticks, and not so much in the center of the patterns. In passing, it might be well to mention that the opening, *A*, Fig. 1, is a joint where the sand occasionally sticks, as the molder in blowing the parting off his patterns, blows it off this space also, and forgets to replace it. After a few mishaps of this kind, he soon recognizes the fact that where sand surfaces come in contact, it is necessary to provide some efficient means of separation, otherwise they will stick.

Mixture For Sand Match.

The construction of the flask is clearly shown by the illustrations. It will be noted that it is a neat, easily handled wooden flask, the sides extending 2 inches beyond the ends, so that the bars, *DD*, Fig. 1, which are fastened across the center of the ends, provide very efficient handles. An extra cope is necessary for the match and it should be provided with pins, *AA*, Fig. 3. After the first drag has been made, the match is rammed off this cope in oil sand, or it may be cast of plaster of paris. Oil sand, however, is to be preferred, and a formula that can be recommended is as follows:

	Parts.
Finely sifted gangway sand.....	89
Finely sifted steel or iron borings.....	1
Pulverized litharge	3
Boiled linseed oil	7

Mix the sand, borings and litharge when dry, taking care to keep out all molding sand, gravel or water, and after thoroughly mixing, add 7 parts boiled linseed oil, and mix to the temper of molding sand. This is rammed hard into the cope match and a bottom board is bedded-on, and afterward firmly secured by screws in preference to nails. A match made in this manner will last for years, outlasting several plaster of paris matches, and when completed, will present the appearance shown in Fig.

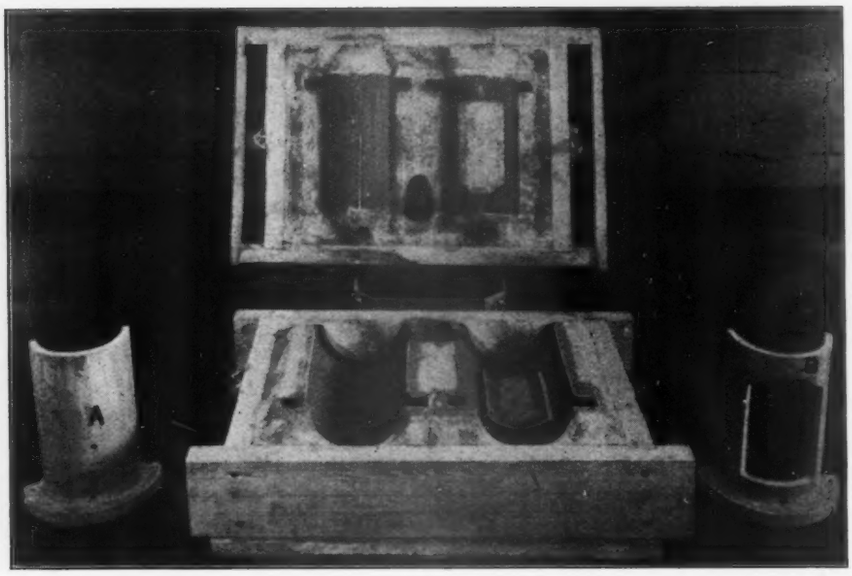


FIG. 2—COPE AND DRAG HALVES OF MOLD WITH THE TWO HALVES OF THE BEARING AT *A* AND *B*

3, where the match and patterns are shown ready to mold. It will be found a great convenience to make the flasks interchangeable, by fitting all the drags to the match before the pins are put on the copes. This insures the patterns occupying the same relative position in each mold, otherwise the cope will not fit down, as the lifting wires would strike against the patterns if they were not in their proper places. These wires are very efficient for lifting bodies of green sand and greatly simplify the ramming of the cope, as there are no bars to be tucked.

Before this scheme was adopted, the usual wooden bars were used, pocketed at intervals by cross bars, which extended into the bearing cavity, and were cut circular to fit the same. This required considerable tucking of sand, and as the bars were liberally nailed, resulted in frequent stubbing and scratching of fingers. In addition, the bars burnt out and much time was lost in renewing them. Another scheme, therefore, had to be devised, and ultimately the wires were adopted with complete success. The manner in which the wires are carried is shown in the view of the cope in Fig. 1. The wooden cross bars are made of 2-inch stock, cut to a wedge shape on the inner side, the other side being flat and flush with the top of the cope. They do not extend close to the joint of the flask, as they are merely used to stiffen the cope and to carry the wires. They are pierced with a number of ¼-inch holes, through which the loops are threaded. Twelve loops are required for each cope, and they can be easily bent to a template. The legs of the loops should be sufficiently long to extend about 1 inch higher than the top of the bar. This is then bent over until it forms a hook, or staple, and is pounded back into the bar, thus securely and rigidly fastening the wire loop. The end of the wire that has to be driven into the wood, can be pointed very easily by cutting it off at an angle. When the wires are being made, they are so adjusted that they extend very near to the pattern at all parts of the half circle, and should not be further away than ⅛ inch. They should be wet before the cope is rammed, as they then hold the sand better. It will be seen there is nothing that needs tucking, and the rammer has free and unobstructed play in ramming the cope. All that is necessary is that the sand is properly packed next to the patterns, so that there are no soft spots. The method of gating is shown in Fig. 2, which illustrates a mold finished and ready to close. Fig. 4 shows the method of pouring off.

As previously stated, the metal should be adapted to the purposes of a bearing, and when all scrap is used, the mixture should be leaded, both for the purpose of making it machine freely and to improve its anti-friction qualities. In making new metal, a good alloy consists of copper 78 per cent, tin 7 per cent, lead 15 per cent. This is a good bearing alloy, and one that will give the minimum amount of trouble in the machine shop. While brass or bronze is undoubtedly the best metal to use for this class of work, and the formula given will prove very satisfactory because it possess both strength and anti-friction qualities and at the same time is stiff enough not to crush, still, bronze axle brasses are expensive, not so much on account of the metal cost, but largely because of the machine work necessary. Therefore, malleable iron shells, lined with an anti-fraction alloy, have been substituted and are largely used. These shells are provided with holes and are dovetailed, to secure the babbitt, and when the latter is worn out, it is removed and the shell rebabbitted, when it is again ready for use. Machine work is, thereby, eliminated and a cheaper bearing results. The idea is to use the malleable shell an indefinite number of times, but in order to do so, they should be promptly removed when the babbitt is cut away, otherwise the axle will be apt to cut the shell and ruin it.

Zinc Babbitt.

The anti-friction alloy used in the shells is generally a zinc babbitt, and for this reason, worn out linings should never be removed by being melted out in a kettle containing genuine babbitt, because the zinc will ruin the latter by making it drossy and thick. They should be melted out in a separate kettle, and the metal used again in relining the shells. The analysis of this metal is as follows: Tin 56.46 per cent, zinc 38.6 per cent, antimony 1.54 per cent, copper 2.15 per cent, lead 0.63 per cent,

FIG. 3—THE OIL SAND MATCH

PUBLIC LIBRARY
No. 605 J63
DETROIT, MICH. Y. 37 1938

iron and aluminum 0.6 per cent. The iron may be regarded as an impurity, as well as the lead, but the aluminum is used for imparting fluidity, and if the re-melted metal shows a heavy, thick, purplish scum on the surface, it should first be fluxed with sal-ammoniac, which will reduce the scum to metal. A small amount of aluminum should then be added, the quantity of which may have to be varied according to the condition of the metal. After an addition of ¼ ounce of aluminum to 100 pounds, a sample ingot, when poured, should run freely and set without any purplish coloring on top. If this result is not attained, a further addition of aluminum is necessary, and the effect of the latter can be better observed if, before it is used, a sample ingot of the babbitt is poured.

Pouring the Ingots.

In all cases the ingots should be poured from one end. The metal should be very fluid, which is better noted by the manner in which it flows to the opposite end. Before being fluxed with aluminum, the babbitt will frequently run so sluggish that it will not flow as far as the opposite end of the ingots. It will show a purplish color on top, and such metal will be found very difficult to run into the narrow space between the mandrel and shell. It will be found practically impossible to use it over again unless treated as stated.

FIG. 4—POURING ONE OF THE MOLDS.

Another Bearing Alloy.

Axle bearings are sometimes made of an alloy of zinc, copper and aluminum, the proportions being zinc 86 per cent, copper 10 per cent, aluminum 4 per cent. This alloy can be cast in metal molds, and should possess a dense, fine-grained fracture. It has a tensile strength of 37,600 pounds per square inch, with no visible elongation. Consequently, it will not bend, but breaks like cast iron. Its strength, however, is so great when properly made, that it takes a good blow of a sledge to break such an axle bearing, and the pieces are liable to fly about in an unpleasant manner. It is a valuable anti-friction metal, and gives good service in the form of axle bearings. Occasionally, however, it will break while in service, especially in very cold weather. Bearings made of this metal can be identified with difficulty from iron when covered with grease and oil, and are often mistaken for such by the car repairers, and thus find their way to the scrap iron pile.

Alloys of Nickel and Cobalt with Chromium*

By Elwood Haynes

NICKEL and cobalt have always possessed a peculiar interest for the chemist. Like nearly all of the more recently discovered metals, their compounds were known before the metals themselves were discovered. It has been known for centuries that certain substances were capable of giving a blue color to glass, and there is but little doubt that this peculiar power was due to some crude compound of cobalt. About two centuries ago, the ores of cobalt and nickel were encountered in the mining of copper. It was at first supposed that they were ores of the latter metal, but the miners, after vainly striving to smelt the ore, and failing to obtain any copper from it, designated it as *Kupfernick*, and from this expression, the word, *nickel*, originated. Attempts were also made to smelt the ores of cobalt, but, as no useful metal resulted, it was concluded that the goblin, or *Kobold*, supposed to inhabit the mines, had placed a ban upon the ore, and thus rendered it incapable of producing valuable metal. From this designation by the German miners, the name, *cobalt*, was derived.

It was not until 1751, that Cronsted published the results of an investigation which he had made upon an ore obtained from the mines of Helsingland. This ore yielded a brittle metal, and as it occurred most abundantly in *Kupfernick*, he suggested for it the name, *nickel*. A few years later, in 1776, it was discovered that nickel was evidently one of the constituents of a Chinese alloy, known as *packfong*. The use of nickel in German silver began about 1823. It was not, however, until 1857 that Messrs. Deville and Debray, the celebrated French chemists and metallurgists, prepared pure nickel by heating its oxalite in a lime crucible. From the pure metal thus obtained, wires were made which showed a tensile strength superior to that of wrought iron. The wire also showed considerable toughness and, when polished, presented a bright, silvery appearance and retained its luster for an indefinite period, under all ordinary atmospheric conditions.

A few years later the art of electroplating was discovered and has since received a very wide application. Tons of the double sulphate of nickel and ammonia are used for this purpose every year. Besides this latter application of the metal, it is now used in large quantities for the manufacture of nickel steel, which has become a common material for the making of naval guns, projectiles, armor plate and high class automobiles.

History of Cobalt.

The history of cobalt is similar to that of nickel, except that the compounds of cobalt were used in the arts instead of the metal itself. In fact, but little was known of the metal until 1857, when Deville produced the pure metal in practically the same manner that nickel was prepared. It was found that cobalt was even stronger than nickel, possessing a tensile strength of about 65,000 pounds per square inch. Indeed, up to that time it was the strongest pure metal yet discovered, and it still holds this position, with the possible exception of tantalum.

Early Experiments.

About the year 1895, I made a number of tentative experiments relating to the production of alloys of nickel with iron, chromium and other metals. The fusions were made in small graphite

*Read at the San Francisco meeting of the American Chemical Society.

crucibles, which were heated in a blast furnace of the Fletcher type, operated by natural gas at a pressure of 40 pounds or more per square inch. With a suitably arranged furnace of this character, temperatures ranging up to the fusing point of the most refractory Missouri fire clay were readily obtained. I succeeded in obtaining by this means, alloys of nickel and chromium, which contained, however, a considerable amount of carbon and silicon. A small quantity of aluminum was sometimes added to the alloy in order to improve its quality. By this means, I obtained an alloy of chromium, nickel and aluminum, which was hard and brittle, but possessed fairly good color and luster. From this alloy a knife blade was formed, which showed fair cutting qualities and considerable resistance to atmospheric conditions. It was readily soluble in nitric acid, and, after long exposure to the atmosphere of a chemical laboratory, it became tarnished, showing a greenish coating on its surface.

Nickel and Chromium.

Later I attempted to produce alloys of nickel with chromium and titanium by means of an electric furnace, made from blocks of quick lime. This proved unsatisfactory, but I continued experimenting with the gas furnace and finally succeeded in producing an alloy of nickel and chromium entirely free from carbon by heating the pure mixed oxides of the two metals with powdered aluminum in a crucible lined with pure oxide of aluminum. The reaction was so violent that most of the metal was thrown from the crucible. A few small pellets were saved and these showed great malleability, flattening readily under the hammer without cracking. The alloy possessed a fine color and, when polished, exhibited a beautiful luster. Larger pellets were soon obtained and it was found that when the chromium content much exceeded 10 per cent, the alloy showed remarkable resistance to chemical reagents, particularly to nitric acid.

Cobalt and Chromium.

At about the same time I reduced a mixture of sesquioxides of cobalt and chromium, with powdered aluminum, and thus obtained minute pellets of an alloy of cobalt and chromium. The little particles, thus produced, were not much larger than pinheads. They were found to be remarkably hard and could not be scratched by a file. A few of these were ground off on one side by means of carborundum and showed a brilliant luster. It occurred to me that the metal might become serviceable for cutting instruments. A short time after these experiments were made, I was called actively into the automobile business and thus compelled to abandon further experiments along this line for some time.

In 1905, I repeated some of the former experiments, with a view to utilizing the alloys of cobalt and nickel with chromium for ignition points in connection with gas engines. I was soon able to produce both the alloys of nickel and cobalt in considerable quantity. I ascertained that the nickel-chromium alloy could be worked cold, while the cobalt-chromium alloy must be worked hot, in order to obtain any degree of satisfaction.

The first pellets of the cobalt-chromium alloy, weighing from 15 to 30 grams, were obtained by heating mixtures of aluminum with the oxides of cobalt and chromium in crucibles lined with oxide of aluminum. Some of these pellets were heated to redness and flattened out under the hammer, and while this could be done without cracking the alloy, the metal was found to be very hard, even at a red heat. I soon found that it was impracticable to reduce the alloy in this manner in large quantities. I accordingly purchased a considerable amount of pure cobalt and pure chromium and had a mixture of nearly equal parts of these metals fused in an electric furnace, the metals being placed in a carbon crucible lined with pure magnesia. The alloy was cast into a small bar, about ¼ inch square and 5 or 6 inches long. This alloy exhibited most of the characteristics of that obtained by reduction with aluminum, but it could not be drawn to any extent under the hammer without cracking. Whether this was due to the high percentage of chromium or to slight impurities in the metals employed, I am as yet unable to say.

Malleability of the Alloy.

To determine what the effect of alloying the cobalt with smaller percentages of chromium would be, I again had recourse to the gas furnace and succeeded in melting a mixture containing 75 per cent cobalt and 25 per cent chromium in a crucible made of a very refractory material, which I compounded for the purpose. Much to my satisfaction, I succeeded in melting this alloy to a perfect fluid and poured it into an ingot mold, which gave me a bar of metal about ½ inch square and 5 or 6 inches in length. This metal proved to be very sonorous and elastic and, if some care were used, it could be hammered out into a rough strip.

After a considerable amount of experimenting with various purifying agents, I finally succeeded in producing a very tough and malleable alloy, which could be hammered into the thinnest sheet at a bright red heat without showing any signs of cracking. A razor blade was made from a bar of the alloy, and while it did not prove equal to the best steel for this purpose, it has been used hundreds of times for shaving purposes and, after a year and a half, shows practically no signs of wear, though, of course, it has been necessary to strop it frequently in order to keep it in good condition. This bar was made about two years ago and I am sure that I have since produced a metal that would be much more satisfactory for the purpose.

Physical Tests.

Tests of this material showed an elastic limit of 79,000 pounds, tensile strength of 96,000 pounds and an elongation of 3 per cent. It will be seen that both the elastic limit and tensile strength of this material are superior to those of untreated steel, resembling more nearly those of good nickel steel. The elongation is quite low, but this is to be expected, on account of the great hardness of the alloy, which is equal to that of mild tempered tool steel. A test was also made of the modulus of elasticity of this material, which was found to be about equal to that of steel. This is a very significant fact, since heretofore it has not been possible, so far as I am aware, to form an alloy of nonferrous metals which would show a modulus of elasticity comparable to that of iron and steel, and it is the lack of this valuable property in various nonferrous mixtures which renders them inferior to iron for many important purposes.

A pocket knife blade and several table knife blades were made from this material and were found to be very satisfactory in every respect. One of these table knife blades has now been in use for more than two years in the kitchen, where it was used for all sorts of purposes, such as cutting bread, turning griddle cakes, peeling and paring vegetables and for various other purposes, such as are known only to the culinary art. After all this use and abuse, the knife shows not the slightest trace of tarnish and has held its luster so well that when exposed to the sun, it shows a reflection which dazzles the eyes. By mixing the alloy with small quantities of other substances, its properties may be modified to a remarkable degree. By this means I have obtained alloys or combinations which, while very brittle, would readily scratch quartz crystal. By reducing the quantity of chromium to some extent and adding certain other materials, alloys which are practically proof against nitric acid, can readily be

obtained, which are sufficiently soft and malleable to be worked cold, having a hardness not much greater than that of mild, untempered steel.

Cutting Qualities.

Between these two extremes, a great variety of combinations can be made, which are suitable for use for various purposes. For example, I have produced an alloy of sufficient hardness that, when formed into a small bar, say ½ inch wide, ¼ inch thick and 3 inches long, and one of the ends shaped for a cold chisel, a 20-penny nail can be cut in two without marring the edge of the chisel in the slightest degree. I have formed another alloy into a small lathe tool, about ¼ inch square and 3 inches long, which showed cutting qualities comparable to high-speed tool steel. In fact, in some respects, especially under high speed and light cuts, it has stood the test for a long time where high-speed steel failed almost instantly, on account of the intense heat generated. I wish it distinctly understood, however, that I do not recommend this material, as yet, for lathe tools, though it would have a high value for this purpose if it were not obliged to compete with alloy steels.

An alloy of 75 per cent cobalt and 25 per cent chromium, to which small quantities of other metals are added, is not only sufficiently hard for good edge tools, but is quite tough and can be bent much beyond its elastic limit without cracking, resembling in this respect the alloy steels, but, generally speaking, it is much harder. A bar of the alloy, ¼ inch square, can be bent cold at right angles without showing any signs of cracking.

Chemical Properties.

When the mixture of cobalt and chromium is heated to whiteness in a crucible, the cobalt first commences to fuse and immediately begins to combine with the chromium. If the metals are mixed in the proportion of about three parts, by weight, of cobalt to one part of chromium, a eutectic is formed which seems to possess a lower melting point than either cobalt or chromium. This is all the more remarkable because the melting point of pure, carbonless chromium is exceedingly high.

The color of the alloy lies between that of steel and silver and is specially pleasing in a bright light. The alloy is also readily polished, but requires special treatment in order to develop its highest luster.

Resistance to Corrosion.

The most remarkable property of this combination, however, is its resistance to corrosion. It is equaled in this respect only by gold and the metals of the platinum group. It is attacked slowly by dilute hydrochloric acid and somewhat vigorously by the strong acid, especially when heated. Momentary exposure, however, to either dilute or strong hydrochloric acid has practically no effect upon the metal. Both strong and dilute sulphuric acid attack it very slowly when cold and not very rapidly even when heated. Nitric acid is totally without action upon it and a polished piece of the alloy may be boiled in it for hours without affecting the luster of the metal in the slightest degree. Solutions of the caustic alkalies are also totally without action upon it, even when boiled for hours. The alloy is likewise proof against all atmospheric influences, whether the air be moist or dry, and retains its brilliant luster for months or even years, under severest conditions. Even sulphuretted hydrogen, when present in the atmosphere in large quantity, is totally without influence upon it.

Heating the Alloy.

When the metal is heated in contact with the atmosphere, it retains its color up to a temperature approaching a dull red, or about 500 degrees Cent., when it shows a faint straw color, which deepens as the temperature rises, passing through bronze-yellow, purple and blue, and finally terminates in blue-black. The alloy shows no scales, even when heated to bright orange, and the film of oxide does not seem to increase in thickness after prolonged heating. It can readily be melted in an open crucible in a gas furnace, with practically no oxidation, so long as a slightly reducing flame is maintained. This is all the more remarkable on account of its high melting point, which seems to be about 1,650 degrees Cent. for the 25 per cent alloy. This metal has been melted in this manner with a loss of less than ½ per cent.

The uses for any substance may be limited in several particulars; first, by the limitations of its fitness; second, by the possibility of producing it in proper form; and third, by its cost. This material is particularly suitable for all kinds of small cutting instruments, since it takes an edge comparable to that of tempered steel. It is especially adaptable to the manufacture of pocket knives, on account of the beauty of its color and the brilliancy of its luster, both of which remain permanent under all circumstances, thus giving the blades a particularly attractive appearance. Knives of this description may be used for cutting fruit without danger of marring their luster in the slightest degree. Alloys in certain proportions will also doubtless find a wide use for surgical instruments, since they resist perfectly all sterilizing solutions. The alloy is perhaps better adapted for table cutlery than anything that has ever yet been produced. We all know that a silver-plated knife, for example, is not adapted for any service requiring a sharp edge, and it cannot be sharpened without destroying the plating. Steel knives, on the other hand, while they cut well, require endless labor to keep them in presentable condition and, at best, they are unsightly in appearance.

The alloy is also of considerable interest to the chemist and physicist. It is admirably adapted for the manufacture of fine weights for balances, scrapers, spatulas and other laboratory appliances. To the physicist, it furnishes a material at once hard, lustrous and untarnishable, and hence well adapted for the manufacture of fine weights, measuring instruments and various small tools. The alloy is also particularly well adapted for the manufacture of standard weights and measures, and it is difficult to see in what respect it is inferior for this purpose to the expensive platinum-iridium alloys now in use. The alloy could readily be made into laboratory vessels, cooking utensils, spoons, forks, etc., and is limited in this respect only by its cost.

Cost.

Regarding the cost of production and manufacture, I am not at present prepared to make definite statements. I have succeeded, however, not only in obtaining the raw materials at lower prices, but have also reduced the cost of production.

Blow-Holes in Aluminum Castings

The repair of aluminum castings having large blow-holes, or which have been misrun, is a comparatively easy operation when the burning-on process is practiced. In one large plant the castings are examined for blow-holes or other apparent imperfections, before the cores are removed. In case of a large blow-hole, a cake core is used, having a hole cut in the center exactly the size of the hole in the casting. A flow-off is cut in one end of this core to carry off the metal, and while the aluminum is being poured from the ladle, the core is held firmly in position on the casting, to prevent lifting. Before the metal in the core opening has set, the surplus aluminum is struck off to nearly the surface of the casting, which greatly improves the appearance of the job and reduces the amount of machining necessary.

Brass Foundry Difficulties

SOLVED BY EXPERTS

Copper Castings of High Conductivity

We are desirous of making copper castings that will be sound and nonporous, and at the same time will have a conductivity of over 70 per cent. We have no trouble at present in casting copper that is absolutely solid, but we do this by sacrificing the conductivity.

Magnesium is the only deoxidizer that can be employed without a reduction of the conductivity, for making solid copper castings. The copper must be very carefully melted, excluding it from the air as much as possible by a cover of charcoal and the use of common salt. When thoroughly liquid, 2 ounces of stick magnesium to each 100 pounds of copper must be added by means of a pair of long-handled tongs, with which the magnesium is plunged below the surface of the copper, and held until the reaction has ceased.

The metal should then be thoroughly stirred, with a plumbago stirrer, and reheated for 5 minutes, before being poured. This will give a conductivity of about 85 per cent, when high grade ingot copper is used. In all cases, the ingot copper should be tested for conductivity first, as sometimes it contains impurities which seriously effect these qualities. The use of silicon-copper will give a conductivity anywhere from 54 to 60 per cent, when used in quantities of 1 or 2 per cent. The smaller the percentage of silicon used, the higher will be the conductivity. We have obtained solid copper castings by using only 4 ounces of 10 per cent silicon-copper to 100 pounds of copper, the metal being carefully melted under charcoal, but not poled. This is a very low silicon content, however, and it may be found necessary to use a little more, say 6 ounces.

It is claimed that copper castings of very high conductivity can be made by the poling process, which consists of stirring the molten copper slowly and steadily with a stick of green hardwood, taking samples from time to time, and pouring into small ingots. By the shrinkage of the top of the ingots the condition of copper can be determined, and also by breaking in a vise. It will be found necessary, however, to also use some deoxidizer, such as silicon-copper or magnesium, and the process permits the quantity of the deoxidizer to be so reduced that the conductivity remains high. If you are successful in obtaining sound castings with magnesium, you would probably not wish to experiment, but if not, the poling process is the only method you can try, with the possibility of getting a conductivity over 70 per cent.

Plumbers' Solder

I would like to have a mixture for plumbers' solder to be used for wiping joints on lead pipes. Can a mixture of 75 per cent lead and 25 per cent zinc be used for that purpose?

For wiping solder use the following: Tin one pound, lead two pounds. We think you will experience considerable difficulty in making an alloy of 75 per cent lead and 25 per cent zinc, and if you did succeed its melting point would be too high for a wiping solder, as it would burn the cloth.

Brass Mixtures for Fittings

We would like a brass mixture for gasoline engine fixtures, also one for propeller wheels, using all new metals, but as cheap as possible.

A suitable mixture for fittings is copper 85 per cent, zinc 10 per cent, tin 3 per cent and lead 2 per cent. This can also be used for propellers, but a better mixture is copper 88 per cent, tin 10 per cent and zinc 2 per cent.

Manganese Bronze

We have an order for automobile castings, which are to be made of manganese bronze, the tensile strength of which must be 70,000 pounds per square inch. Can you inform us how we can make these sections?

The tensile strength of a manganese bronze casting depends upon so many factors, aside from the particular formula used, that it is very difficult to advise you briefly how to duplicate this high grade alloy. The manner in which the metal is melted and alloyed, the method of gating and feeding, and the temperature at which the castings are poured, all have a vast influence on the physical properties of this bronze. As practical experience is necessary to master these points, many disappointments will be the lot of the novice, who attempts and expects to duplicate the excellent results of experienced makers of these alloys.

To obtain high tensile strength, the zinc content must be high, and when this is the case, if the alloy is not properly mixed, the metal will be crystalline and will have a low per cent of elongation. Furthermore, high grade metals must be used. The copper and zinc should be the best obtainable. A formula that has given excellent results follows: Copper 26 pounds, melt under charcoal, and gradually add one pound of tin plate clippings in small pieces; when these are melted, add 22 pounds of zinc, previously heated, and 1 pound of tin. Stir thoroughly and pour into ingots. Then melt 26 pounds of copper under charcoal, and when liquid, add 4 pounds of 30 per cent manganese-copper and 20 pounds of zinc. Pour into ingots.

The alloy is formed by melting 49½ pounds of the first preliminary alloy, to 50 pounds of the second, and adding 8 ounces of aluminum. The metal is then melted twice, the object being to mix it thoroughly. The process can be varied a little by adding the first alloy to the second, while it is fused, instead of pouring into ingots, but the results may not be as satisfactory.

When making test bars, use a square pattern instead of a circular one, and incline the mold, carrying the runner to the lowest end so that the metal will rise. Take off a large riser from the center of the bar on top, to feed it, or cast a coupon on the lower edge of the casting, where it will be sure to come clean, and where it will be fed up dense.

Iron in Brass

We would like to know if it is possible to separate iron from brass borings, and whether too much iron is a detriment in brass for bearings. Can all brass be made free from blow-holes, irrespective of whether scrap or new metals are used?

There are several machines on the market which are very efficient in removing iron from brass turnings, and it is very important that it be removed, as its presence causes serious difficulties

in casting and machining brass. Some of the troubles from this source are abnormal shrinkage and dirty, black, ugly looking castings. The iron is found scattered throughout the metal in the form of little lumps ranging from mere specks to the size of a pinhead, and so hard that they resist the file, and thus play havoc with the tools. A casting containing iron in this form makes a very poor bearing, as the little nodules score the axle. Therefore, it is especially desirable that the iron be removed before the turnings are melted, and this is quite easy of accomplishment with the machines on the market.

There is no difficulty in obtaining perfectly sound brass castings from either new or old material, provided only, that it is carefully melted, and that the scrap used is good, because if it contains pinholes or blow-holes, these will be accentuated by remelting, if no deoxidizing agent is used to cause their removal. It is always desirable to use a little phosphorus when remelting turnings or scrap of unknown composition, and from 1 to 2 per cent of 15 per cent phosphor-copper is recommended for this purpose.

Brass Crystallization

Some time ago, we made several brass condenser heads, 3 feet in diameter and 1⅛ inches in thickness. The tops and bottoms of the castings were clean, but on boring them for the tubes it was found they were split through the center edgewise. All the castings were the same. Can you tell us what caused this, and what alloy to use to prevent future defects of this nature?

These castings must have been allowed to cool very slowly, as the trouble was caused by the manner in which the metal solidified, permitting the formation of crystals. They arranged themselves axially, radiating from the center of the outer skin of the casting, which naturally cooled first, being chilled by the sand, and as the metal began to form crystals, they attached themselves to the solidified skin and began to grow inwardly, projecting like peninsulas into the liquid center. This happened on both the cope and drag sides of the castings, and the formation of the crystals was accompanied by the absorption of the liquid portion to make up the shrinkage, until it was all drained away, and the center was hollow. In other words, the shrinkage took place in the center of the casting, due to the formation of large crystals, which was favored by slow cooling, and the part of the casting which cooled most rapidly could be determined by the distance of the shrinkage from the center. Thus, if the split occurred exactly in the middle of the casting, then both cope and drag cooled equally, but if it occurred away from the middle, so that the upper crust was thickest, then the cope cooled first.

This trouble is frequently met with in flat bronze castings, containing over 5 per cent tin, and sometimes they can be split in two parts when the edges are faced off. This could be remedied by a rapid cooling of the casting, but as there is no feasible method of doing this in the foundry, it is better to change the mixture to one that has less tendency to form large crystals, and is more granular in structure. Two alloys that can be recommended are as follows: (1) Copper 86 pounds, phosphor-copper (15 per cent) 4 pounds, tin 7 pounds, lead 3 pounds; (2) copper 86 pounds, tin 9 pounds, zinc 1½ pounds, lead 3½ pounds, yellow phosphorus 6 ounces.

Flux for Brass

Is glass a good flux for brass? If not, what flux would you advise me to use?

Glass is not a flux, but merely a covering for brass, as it melts into a viscid mass, excluding the air. For this purpose it is excellent. If you desire a flux, we recommend the use of common salt. It should be placed in the crucible at the beginning of the heat, and two tablespoonfuls will be sufficient for 100 pounds of metal.

The Brass Scrap Pile---I

AN ever-increasing use of aluminum and silicon in the non-ferrous alloys presents a serious problem to both the scrap metal dealer and the brass founder, who purchases scrap metals, as it is impossible to identify alloys which contain these elements and to pick them out of the good scrap. A casting that has been machined and has served its period of usefulness on the scrap pile, bears a familliar resemblance to other pieces of scrap. The experienced eye can only determine between *yellow* or *red* brass, and there are even exceptions to this rule, as quite a number of manganese bronzes are red when cut, and cannot be distinguished, when in the form of chips or scrap, from the tin bronzes.

Metal made from the formula, copper 63-64, zinc 36-37, is just as red as any bronze, and will pass for this metal every time in the form of scrap. When these conditions are taken into consideration, the conviction arises that the scrap metal question has become a very complicated one, especially in these days of a multiplicity of alloys. Alloys of copper and zinc that resemble bronze, however, do not cause any great trouble to the brass founder, unless they contain percentages of aluminum or silicon, or both. Then they are more mischievous than yellow scrap, because they are used in the bronze mixtures and spoil the entire heat. The metal then has to be run into ingots, and generally the balance of the scrap is returned to the scrap metal dealer, although there might not be another piece of the trouble maker in the entire pile.

Judging Scrap.

Fortunately, manganese bronze and other high zinc alloys, containing aluminum, are so difficult to cast that they have not greatly superseded phosphor bronze for engine work, even in places where they could be used to advantage. Therefore, the shape of the scrap is often a reliable guide in judging the kind of metal which enters into its composition. For instance, engine bearings, particularly those that are recessed for babbitt, can generally be regarded as a rich alloy of copper and tin, entirely free from either aluminum or silicon, many of them being made, even in these days of expensive tin, of a mixture of 6½ or 7 parts of copper to one of tin, with small percentages of zinc and lead. The smaller sizes and the ones not recessed are very often made of ordinary tin bronze scrap, or of the well-known alloy, 80 pounds copper, 10 pounds tin and 10 pounds lead. Such alloys as these are, therefore, not objectionable. Besides such bearings, there are many other machinery castings that can be relied upon to be good metal; among them may be mentioned, round cast shapes, such as valve stems, etc. These, when over one inch in diameter, are seldom cast in any other alloy than ordinary bronze, and among the smaller castings, there are valves, pump castings of various kinds, oil cups, injectors and brass

work that has been under steam pressure. Therefore, when this scrap has been sorted out we arrive, by an elimination process, at the shapes that can be justly regarded with suspicion.

Mechanical Test.

It would be difficult to give any reliable description of what kinds of castings these might be, but sometimes they can be identified quite easily without any test. This is the case with some brands of manganese bronze, but there are cases where this latter metal, in the form of scrap, would never be identified as a zinc alloy by mere inspection. The chemist, of course, could tell, after certain tests, but there are few brass founders or metal dealers who employ a chemist. Consequently, some rapid mechanical process is required, and this is furnished, in the case of high zinc alloys, by the emery wheel. It will not, of course, show whether aluminum is present, but it can generally be taken for granted that it is in cast scrap, because when the zinc content is high, the addition of aluminum becomes necessary in order to obtain good castings in sand.

The copper-zinc nature of these alloys is indicated when the alloy is ground on the emery wheel, by the discoloration of the cut surface, the rapid heating, and the difficulty with which it is abraded. The discoloration is caused by oxidation, and this is due to the heat generated by friction. Consequently, it will not suffice to merely touch the specimen to the stone; it must be crowded and kept there until it heats, when the cut surface will assume a greenish tint, which is a sure indication of high percentages of zinc. This greenish tint can be noticed on extruded metal shapes; the surface that has been drawn through the dies generally possesses a pretty, greenish-yellow color, which is so permanent that it remains on the pieces until they reach the scrap pile. The cut surfaces will be red, the same as a good tin bronze, but the color of the drawn surface makes it easy to distinguish it from bronze, and this material can be put into its proper place with the yellow brass.

Extruded Metal Scrap.

In passing, it may be remarked that extruded metal will not cause trouble for the brass founder, because aluminum is rarely present. The content of zinc, however, is too high for successful sand casting, and should entire heats of this scrap be melted down, it will be found necessary to add from ¼ to ½ per cent of aluminum. Small quantities of extruded metals can be used in either red or yellow scrap brass without detriment, but as the zinc content generally ranges around 45 per cent, it will readily be seen that any large quantity would make serious changes in the mixture unless a portion of the zinc is left out, and the extruded scrap used as a means of adding zinc. Small quantities of manganese bronze or aluminum brass can be used in new red metals for the purpose of adding zinc, without changing the color of the alloy. In fact, a minute addition of aluminum is a good deoxidizer in bronze, but the amount must be so small that no indications of its presence can be observed on the skin of the castings, otherwise it will cause serious changes in the structure of the alloy, which impair its strength, in addition to making dirty castings. This applies only to red metals, as larger amounts of aluminum can be tolerated in yellow alloys.

Manganese Bronze Scrap.

The amount of manganese or other *bronze*, containing aluminum or silicon, that can be used as a mixture in making red alloys, will depend upon the quantity of these deoxidizing metals which may be present. Cast manganese bronze contains from one-tenth of 1 per cent to 3 per cent aluminum, so that it will readily be seen that it is not possible to use the same quantity of the latter, as of the former alloy, and as no available means exist of determining the exact amount of aluminum present except by analysis, it will be necessary to resort to experiment to find out how much can be used in each heat. It will be better to commence its use in common red castings, where the introduction of a little excess zinc will work no harm. The writer generally commenced with 2 pounds of the manganese bronze and gradually increased this until the limit was reached, this being when the aluminum showed on the castings. The manganese bronze was then reduced until its presence could not be detected. One red metal mixture that proved to be a good, ductile alloy was as follows: Copper 80 pounds, zinc 5 pounds, manganese bronze scrap 10 pounds, tin 3 pounds, lead 2 pounds. The 10 pounds of manganese scrap represented the limit that could be used, and this should be determined as suggested. In this manner, it is possible to use up metal which otherwise would be exceedingly difficult to dispose of, for instance, manganese bronze chips. These are especially handy, as any desired weight can readily be obtained, and it will be surprising how they can be used up, when from 5 to 10 pounds can be included in every heat. The alloy of manganese bronze, of which 10 pounds was used in the red brass given, was as follows: Copper 58½ pounds, zinc 38¼ pounds, ferro-manganese (80 per cent) 2 pounds, iron 7 ounces, aluminum 5 ounces, tin 8 ounces. This is a good, reliable alloy and finds extensive use, and is given here to convey an idea of how to use up manganese bronze, the composition of which is known. Manganese bronze chips are a drug on the market and producers find it difficult to dispose of them even at the very low prices they command.

Manganese Bronze Chips.

The manufacturers of high grade manganese bronze castings cannot use their own chips because they cause such serious reductions in tensile strength that the castings do not come up to requirements. Consequently, the chips must be sold, and new metal used in the castings. The gates and feeders are used over in the less important castings, as even the use of this material causes a drop of several thousand pounds in tensile strength. Large quantities of manganese bronze are used in the automobile business, but the requirements are not so severe, as a general rule, as in the case of rotor vent rings and plates for the Parsons turbine, so the producer who consumes his own castings generally uses up his own chips. In fact a large portion of the manganese bronze used for automobiles is not this alloy at all, but merely a cheap yellow brass fluxed with aluminum. In one foundry the "manganese bronze" was merely scrap yellow brass, into each pot of which the foreman threw a sprue or the piece of a head from an aluminum casting. Such material as this, when it reaches the scrap dealer, is consigned to the yellow brass pile, and ultimately finds its way into the foundry, often to the disgust of the man who made it.

Aluminum in Scrap.

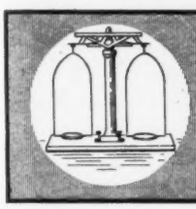
At the present time, the manufacture of brass containing aluminum is increasing at a rapid rate, and some time in the future is going to cause much trouble to purchasers of scrap metals. Large numbers of light brass castings are made in yellow brass, fluxed with either aluminum or silicon, and the reason of this is that these metals eliminate casting troubles so that thin shapes, which were formerly made with difficulty, are now run with ease. An example of this is found in the plumber's ferrule. This was formerly largely run from emery wheel grindings and similarly fluid metals, which had to be poured boiling hot in order to run the castings. Now, by the use of aluminum in a high zinc alloy, they are cheaply and easily made. The formula found most serviceable for this purpose is as follows: Copper, 54.50 per cent; zinc,

40 per cent; lead, 5 per cent, and aluminum, 0.50 per cent. This metal will be found to be surprisingly strong, and of a dense and red-colored fracture. Another class of castings made in these cheap alloys is saddlery hardware, but these castings are too small to cause much difficulty to either the founder or scrap metal dealer at present.

Aluminum is of great advantage in running small yellow brass castings, as it increases the fluidity and suppresses the zinc flare to a great extent, as well as permitting the use of much higher percentages of zinc, thus greatly cheapening the alloy. The ferrule mixture given is an example of the low cost of these metals, and is about as cheap a brass as it is possible to cast in sand. When once the aluminum has been put into the brass, there is no known way of removing it in the crucible, therefore, the metal can only be used for similar castings, or proportioned in making new metals, as previously mentioned.

For heavy castings of yellow brass aluminum does not give good results, as the metal runs drossy, so that heavy yellow castings can generally be regarded as being free from the annoyance of aluminum, provided they are not manganese bronze, and this can often be determined by cutting off a piece and testing it on the wheel.

All manufactured brass shapes, except those made by the extrusion process, are comparatively low in zinc and free from aluminum. These include sheet clippings, screw rod scrap and turnings, etc., and all scrap articles made of spun brass, known to the trade as light yellow scrap. Heavy yellow scrap, which includes all plumbing goods of yellow brass, hand rail trimmings, and connections, are generally free from aluminum, on account of the dross difficulties experienced, so that this material is usually available for the brass pot.



Easy Lessons in Chemistry

By CHARLES VICKERS

OXIDE of copper, to the inexperienced eye, looks like dirt, as all the characteristics of a metal have been lost except weight, and it generally exists in a powdered or granular form, as it is so brittle that it crumbles readily. As previously stated, there are two oxides, one red, the other black; therefore, oxide of copper, as we will call it, always consists of a mixture of the two oxides, the black protoxide predominating. Consequently, the color of the powder is not black, but a reddish brown. When the insulation is burned off scrap copper wire, the latter becomes oxidized, and as much as possible of the scale should be pounded off before it is melted. It will be frequently noted, however, that the burned off wire has lost its metallic brightness, and presents a dull, salmon color. This is due to a coat of red oxide, or more properly, dioxide of copper, which firmly adheres to the wire, so that when it is melted, a larger proportion of oxide is carried into the metal than would be the case had it been clean in the first place. For this reason, when such copper is melted to form an alloy, it is always a good idea to add some substance, such as phosphorus, that will combine with the oxygen and thus remove it from the copper. Such substances are called deoxidizers, because their affinity for oxygen greatly exceeds that of the metal in which they are dissolved; therefore, they are able to take the oxygen away from the metal with which it formed an oxide. The deoxidizer and the oxygen combined, generally form a slag, which rises to the top of the melted metal and is removed when the crucible is skimmed.

All copper contains more or less oxide, which is a source of weakness, and the more nearly it is eliminated when forming alloys, the stronger the metal will be. This is the reason why phosphor bronze is stronger than ordinary bronze, as some of the oxide has been removed by the phosphorus. Manganese bronze is merely high brass from which the oxide has been removed by manganese, or by iron and manganese combined. Iron will remove oxygen from copper, and solid copper castings can be made by its use, as it possesses a much greater affinity for the gas than copper does.

The presence of oxygen in copper in the form of oxide cannot be detected by the eye, but it can be clearly seen when the metal is examined by the microscope. Figs. 1 and 2 are illustrations from photo-micrographs, made by Wirt Tassin. Fig. 1 is a view of a section of a wire rod, which was highly polished and examined under the microscope.

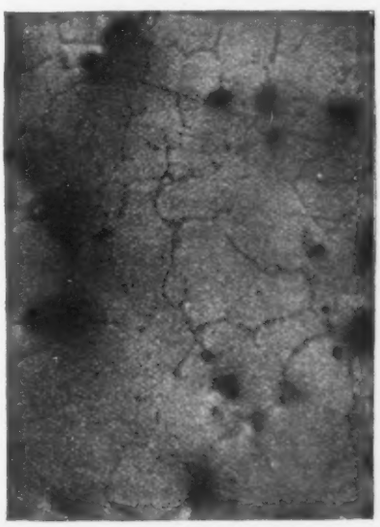


FIG. 1—OXIDE IN ROLLED COPPER

The oxide, it will be observed, forms a net work of cracks with a few large spots scattered throughout. Fig. 2 shows a portion of the same specimen after it has been etched and more highly magnified. The oxide can be clearly seen and it will be readily understood that the strength of the metal is much decreased thereby, as the oxide, being a brittle substance, forms partings in the metal where it can be more easily broken. These specimens were taken from wire rod metal that had been worked and was, consequently, much improved. Fig. 3 is a section of a copper ingot which should be compared with Fig. 1, as it is not so highly magnified as Fig. 2. It will be seen that copper, even in ingots, contains large quantity of oxide, which is increased when the metal is melted. It will, therefore, be readily understood that it is necessary to protect the copper as much as possible from the air while it is being melted.

This is the reason why charcoal is used, as it reduces the oxide by combining with the oxygen and liberates the copper as a metal, but it only does this in a limited way in the crucible, as it floats on top of the molten metal and only comes in contact with the oxide on the surface. For this reason it acts

more as a cover, protecting the metal from the air, than as a reducing agent. Before the copper begins to melt, it remains, for a considerable time, at a red heat. This is the danger period, as the charcoal is of little value, except for the carbonic acid gas which it

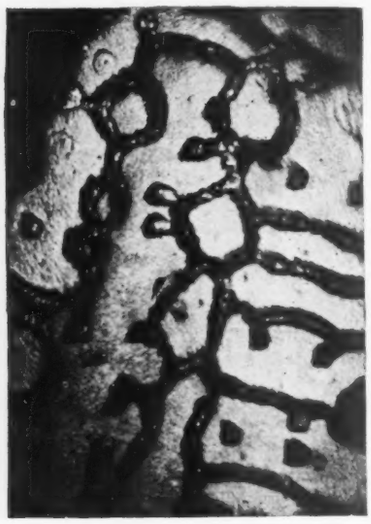


FIG. 2—OXIDE IN ROLLED COPPER AT A HIGHER MAGNIFICATION THAN FIG. 1

generates, and which envelops the protruding copper and protects it to a certain extent. A more efficient agent at this stage is common salt. This emits clouds of white fumes (chlorhydric acid gas) which shield the copper from the air and furnace gases. The quantity of oxide which copper contains has a direct bearing on the quality of the alloy made therefrom. This explains the mystifying circumstance, experienced by many brass founders, why one brand of copper will give good results in making high tensile alloys, and another, apparently as good, will not. This difference between two brands of copper has been known to range in tensile strength, from 5,000 to 10,000 pounds per square inch in manganese bronze, and from 1,000 to 3,000 pounds in phosphor bronze. An excellent method of determining the cause of such differences in the strength of alloys, made from different brands of copper, would be by comparing the photo-micrographs of the two coppers, to ascertain the amount of oxide in each.

It is well known, by brass founders, that pure copper will not make solid castings in sand molds, but swells and flows back out of the pouring head when cast. Consequently, it is necessary to add some foreign element, such as silicon, manganese, phosphorus or zinc, before castings can be made. These substances act beneficially by removing a portion of the oxygen, sufficient to cause the copper to cast without porosity. The efficiency of these deoxidizers can be gaged by the amount it is necessary to use. Thus, while 2 ounces of magnesium are sufficient for 100 pounds of copper, it takes from 2 to 6 pounds of zinc to produce solid castings, according to the care with which the copper is melted.

Cylinder Mixture

By N. W. Shed

Question:—We would like to know what the chemical composition of an iron should be which will have the least possible tendency to draw where heavy and light parts join. The iron must withstand a water pressure of 150 pounds, which is applied to the water jacket portion of gas engine cylinders. We have a well-equipped laboratory and every facility for doing accurate work.

Answer:—The best composition for water-jacketed cylinders is a high silicon, high phosphorus mixture. By adding 10 to 20 per cent of a southern iron, running 4.50 to 5.50 per cent in silicon and 1.50 to 2.00 per cent in phosphorus, the desired iron can be made. This iron should have approximately this composition:

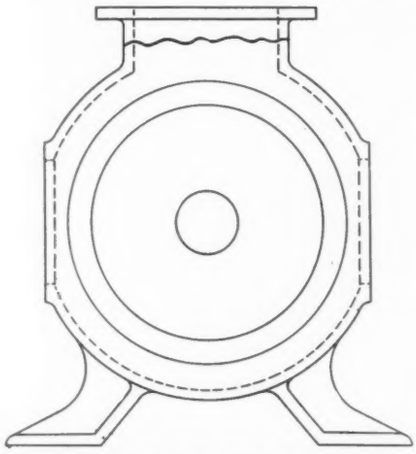
	Per cent.
Silicon	2.60—2.80
Sulphur	0.05—0.08
Phosphorus	0.75—0.90
Manganese	0.65—0.80
Graphitic carbon	3.20—3.30
Combined carbon	0.45—0.60

The graphitic and combined carbon will vary with the thickness of metal and the rate of cooling, but will approach the figures given.

A Burning-on Job

By Fred Ibach

WE recently had a difficult repair job. The cast iron gas engine crank case, shown herewith, had already been consigned to the scrap heap, as the whole of the square flange



GAS ENGINE CRANK CASE REPAIRED BY BURNING-ON

and a part of the neck were broken off. Merely to demonstrate what can be done by burning-on, we undertook the repair of this casting. The neck was surrounded by a square flange, 8 x 8 x 1½ inches, before it was broken.

A dry sand core was made with the

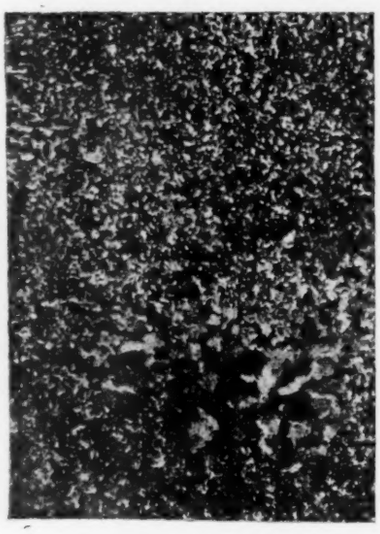


FIG. 3—OXIDE IN INGOT COPPER

broken pieces as a form, and it was made of sufficient length to bear solidly against the casting. A round core was filed to fit the inside and this was made of such a length that it rested in the solid part of the neck. The casting was then set in sand in a vertical position and the cores were firmly held in place by ramming sand around them. A spill-way was cut to carry off the iron. To raise the edges of the casting to the proper temperature, about 800 pounds of iron were poured around the fracture.

After pouring, the new section of the casting was cooled very slowly, to prevent rupture. There was not the slightest trace of a cold-shut, and the metal in the burned-on section was clean and uniform. It machined easily, no trouble being encountered because of hardness or scale.

Although this practice has been pursued in foundries for many years, it again demonstrated its usefulness in this instance, and proves that many castings can be successfully repaired in this way.

A patent was recently issued to James Naulty and John Scanlin, of Philadelphia, on an alloy of copper and chromium, which is said to be "approximately as hard as steel," thereby permitting edged tools to be made therefrom, and adapting the metal for rolling, welding and forging. The copper and chromium are mixed in the proportion of 9 to 1. An alloy consisting of 45 per cent copper, 5 chromium and 50 zinc, is mentioned in the patent.

THE FOUNDRY DATA SHEET, SEPTEMBER, 1910.

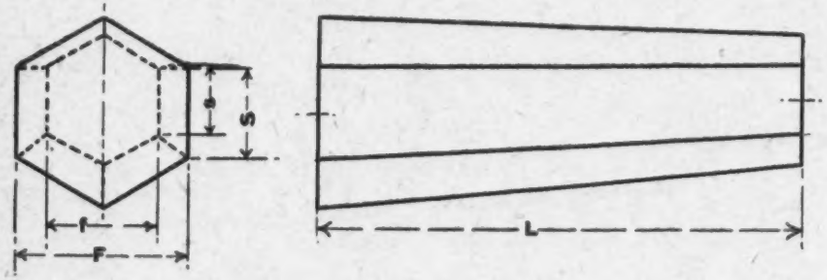
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS.

By W. L. Tryon.

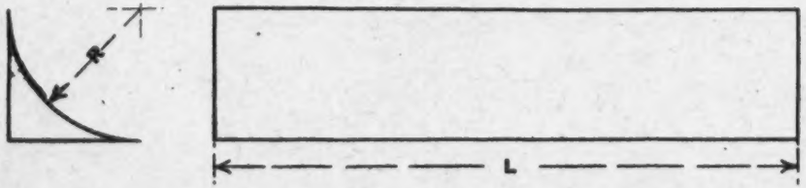
To find the weight of a frustrum of a hexagonal pyramid, multiply the sum of the side of the large base squared, the side of the small base squared and the product of the two sides, by the length by 0.226, or, multiply the sum of the distance across the flats of the large base squared, the distance across the flats of the small base squared and the product of these two distances, by the length, by 0.075.

$W = (S^2 + s^2 + Ss)\ L \times 0.226$, or $W = (F^2 + f^2 + Ff)\ L \times 0.075$.



To find the weight of a straight fillet, multiply the radius squared by the length, by 0.0559.

$W = R^2\ L \times 0.0559$.



W = weight of casting in pounds.
L = length of casting in inches.
S = side of large base in inches.
s = side of small base in inches.
F = distance across the flats of large base in inches.
f = distance across the flats of small base in inches.
R = radius of fillet in inches.

Data Sheet No. 73, The Foundry, September, 1910.

FORMULAS FOR FINDING THE WEIGHTS OF IRON CASTINGS.

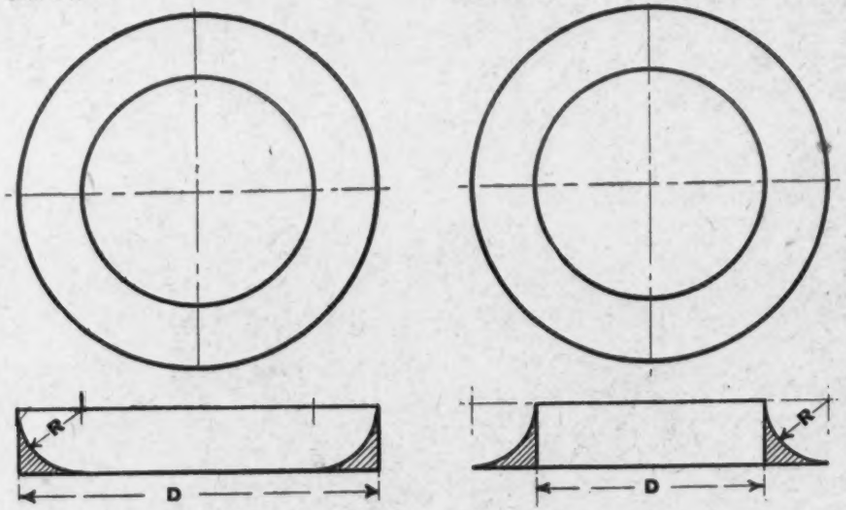
By W. L. Tryon.

To find the weight of an inside circular fillet, multiply the difference between the diameter of the cylinder made by the side of the fillet and the product of the radius and 0.446, by the radius squared, by 0.176, or, from the diameter of the cylinder made by the side of the fillet, multiplied by the radius squared, by 0.176, subtract the radius cubed multiplied by 0.0784.

$W = (D - 0.446\ R)\ R^2 \times 0.176$, or $W = D\ R^2 \times 0.176 - R^3 \times 0.0784$.

To find the weight of an outside circular fillet, multiply the sum of the diameter of the cylinder made by the side of the fillet and the product of the radius and 0.446, by the radius squared by 0.176, or to the diameter of the cylinder made by the side of the fillet multiplied by the radius squared, by 0.176, add the radius cubed multiplied by 0.0784.

$W = (D + 0.446\ R)\ R^2 \times 0.176$, or $W = D\ R^2 \times 0.176 + R^3 \times 0.0784$.



W = weight of casting in pounds.
R = radius of fillet in inches.
D = diameter of cylinder made or generated by the side of fillet in inches.

Data Sheet No. 74, The Foundry, September, 1910.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

CONVENTION OF BRITISH FOUNDRYMEN

Report of the Annual Meeting of the British Foundrymen's Association held at Manchester --- Papers and Discussions

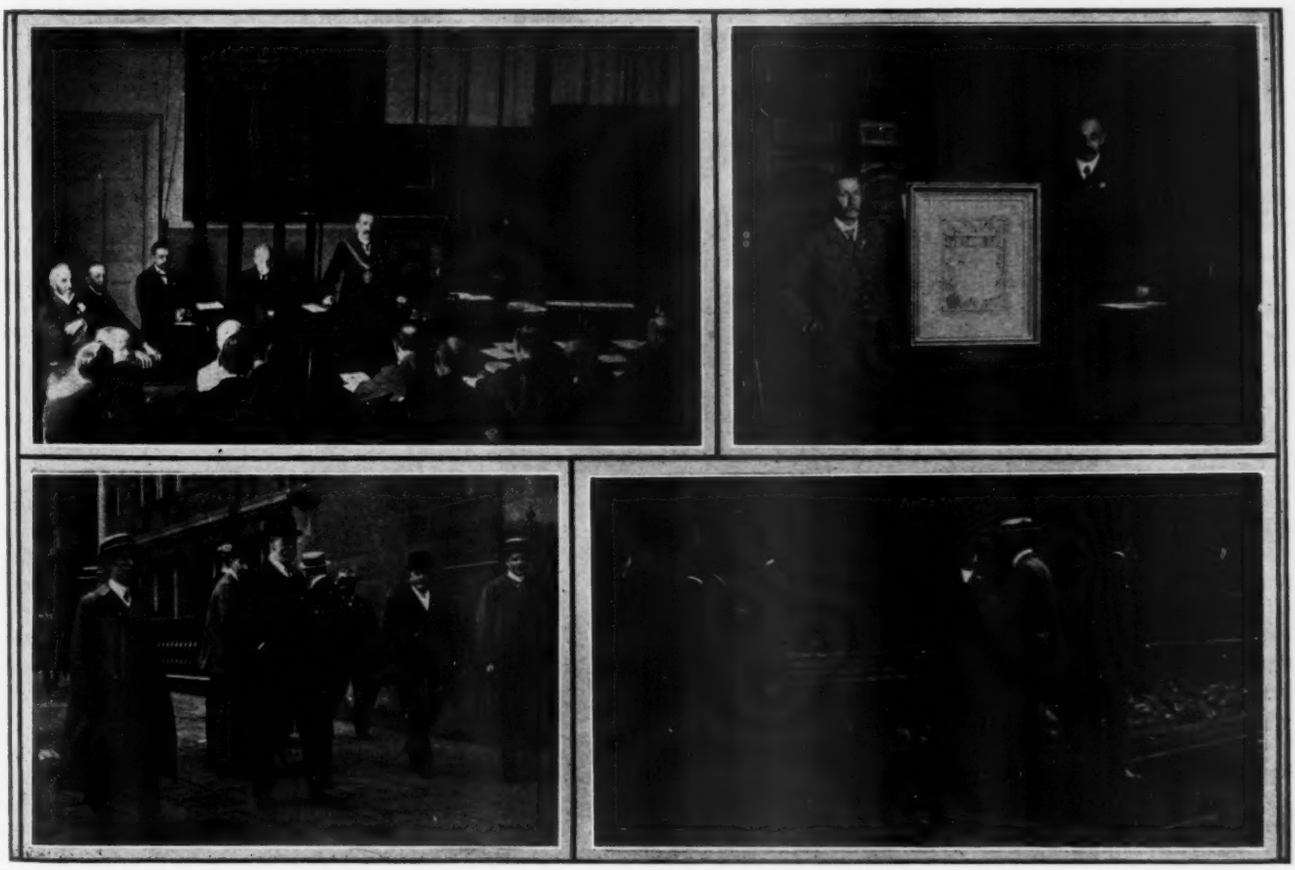
By J. Horton

MANCHESTER, the great British cotton center, was this year chosen as the meeting place of the British Foundrymen's Association, whose annual conference was held on Tuesday, Wednesday and Thursday, Aug. 2, 3 and 4, following the Bank Holiday. The event attracted an unusually large attendance, and for the first time in the history of the association the council found it possible to circulate copies of all the papers in advance of the meeting. The sessions were held in the Municipal School of Technology. F. J. Cook, the retiring president, was in the chair at the opening session, Tuesday morning. He said that the selection of Manchester as this year's meeting place was most appropriate, in view of the fact that the first annual meeting of the society was held in that city six years ago.

This conference received unusual civic recognition, the foundrymen having been welcomed by Hon. C. Behrens, Lord Mayor of Manchester. In the course of his remarks, he said that Manchester was much more than merely a cotton center, as the iron trade is one of the most important of the city's industries. The importance of technically trained men was also recognized, and he added that on a recent visit to Japan he was surprised at the tremendous progress recently made in that country. J. H. Reynolds, principal of the Municipal School of Technology, emphasized the Lord Mayor's welcome in an effective speech.

In his presidential address, Percy Longmuir spoke, in part, as follows:

"Industrial life is not free from criticism, which contends that the practice of today is decidedly inferior to that of 20 or 30 years ago. We frequently hear statements to the effect that Britain is losing her industrial leadership and that the new industries of recent years have been of German, French or American origin. Public speakers and writers may vary the theme, but the underlying spirit is the same, and that spirit spells degeneration. There are some people who boldly assert that 20 years ago failures were unknown. Foundries then produced no wasters, steel works had no difficulties, and metallurgical problems were unknown. This golden age is not familiar to workers of today. A glance at current shop practice shows it to be short of perfection in many



HON. C. BEHRENS, LORD MAYOR OF MANCHESTER, WELCOMING THE MEMBERS OF THE B. F. A.

ILLUMINATED ADDRESS, PRESENTED TO F. W. FINCH, TREASURER OF THE B. F. A., WHO IS AT THE LEFT, F. J. COOK, RETIRING PRESIDENT, IS AT THE RIGHT

DELEGATES OUTSIDE THE MUNICIPAL SCHOOL OF TECHNOLOGY, WHERE THE B. F. A. MEETINGS WERE HELD

BRITISH FOUNDRYMEN, ENTERING THE LOCOMOTIVE WORKS OF THE LANCASHIRE & YORKSHIRE RAILWAY CO.

ways, but in spite of this there are glimmerings of some advance. Some examples of recent progress are to be found in castings for high speed engines, gas engines, and turbines; steel castings have emerged from the gloom of uncertainty into the glare of commercial daylight; brass foundry alloys have advanced from secret and pet mixtures into something approaching a tangible system. Knowledge of metals and alloys is increasing step by step, and traditional empiricism is falling away before the slow, but sure progress of exactitude.

"Investigation will show that standing and direct charges of manufacture have increased materially. The selling price of nearly all classes of castings, however, has decreased, or in the absence of actual decrease, no increase has been made commensurate with other increments. Therefore, unless the founders of this country are in business for health alone, some progress must necessarily have been made in practice, otherwise increased charges could not be met by decreased selling price.

"Another factor, and one of increasing importance, lies in the specifications associated with certain classes of castings. Generally speaking, these have been successfully met, thus offering further testimony to advancing practice. Notwithstanding all difficulties, progress has been made in the art of founding and in the knowledge of the metals handled by the founder. This technical advance is proved by commercial results, and these in turn form an answer to the cry of industrial degeneration.

"Education, as ordinarily understood, is recognized, but unfortunately this recognition is in most cases limited to the ordinary technical curriculum. More advanced work is required and this association should develop work of the type so successfully introduced by Mr. Cook and Mr. Hailstone, at the last convention. We should develop a spirit of advanced study and research into the unknown, and in this direction a gentle plea might be entered for the historical side.

"The rate of development is not now set by one country alone. The leading industrial nations, in vieing one with another, have increased the rate enormously. It does not follow that the more rapid the development the better the final result, but history shows that those countries which do not progressively develop will, eventually, suffer commercially. The development of other countries is a point worthy of careful attention. British foundries have no cause for alarm, and the writer has emphasized the fact that progress had been made. Giving full weight to this, we have still to admit that the future will demand more progress than the past. Viewed from a practical point of view, the cheapest producer controls the market. Knowledge, as shown in the equipment and organization of a foundry, necessarily means power to do good work. The extension of this knowledge is a vital matter to this association, and such extension means research into the unknown.

PERCY LONGMUIR
President B. F. A.

F. J. COOK
Retiring President B.F.A.

J. E H. ALLBUT
Secretary B. F. A.

H. PILKINGTON
Member Council, B. F. A

R. MASON
Member Council,
B. F. A.

"Those who try to anticipate the future, practice current research, and by patient, persistent delving into daily problems, endeavor to locate the cause of troubles in order that remedies may be defined. Commercial research is very fully recognized in Germany, where, in 1907, 2,028 academically trained chemists were employed by 344 firms, and 289 chemical technologists were employed by 88 firms. Today, the most successful industries are those taking advantage of the full range of scientific methods open to them for guidance in present processes and for help in the introduction of new methods. The modern engineer, in partnership with the scientist, is revolutionizing many industries, and the foundry will, of sheer necessity, have to take advantage of this partnership."

One of the pleasant features of the morning session was the presentation of an illuminated address to F. W. Finch, the first secretary of the society, who occupies the position of treasurer. In addition, Mr. Finch was the recipient of a gold watch and pendant from the members of the organization, the presentation having been made by G. M. Mather. Mr. Finch, acknowledging the gifts, declared that his work had been entirely disinterested, and added that he would be pleased to continue his efforts in behalf of the association as earnestly in the future as in the past.

Officers for the ensuing year were then elected, as follows: Percy Longmuir, president; Chas. Jones, Cardiff, senior vice president; R. W. Kenyon, Manchester, junior vice president; F. W. Finch, treasurer; J. E. H. Allbut, secretary.

The report of the Council dealt with the resolution adopted at the International Congress for Testing Materials, held in Copenhagen, which recommended the grading of foundry iron by analysis, instead of by fracture. At a meeting of various associations interested, it was decided that the conditions governing the sale of pig iron in Great Britain made it undesirable to recommend any immediate change in the existing practice of

grading, whether by fracture or analysis. The total membership was reported at 571, as compared with 448 in 1909. During the year a new branch was organized in Glasgow, and a literary committee has been organized to review all papers read before the association. This committee is made up as follows: R. Buchanan, F. J. Cook, R. W. Kenyon, P. Longmuir and H. Pilkington.

F. K. Knowles read a paper entitled "Coke and Its Properties," which is briefly as follows:

"In the foundry the most important metallurgical operations depending upon coke as fuel are, the melting of the iron in the cupola, and in the crucible process for the production of high-class steel. For cupola purposes, coke must supply the heat and carry the burden, and should be selected with a view to the prevention of the formation of carbon monoxide. A dense, nonporous coke should be employed in pieces to suit the varying diameters of cupolas. The reason for this is that when carbon burns to carbon dioxide, the maximum temperature is attained. In cupola practice a plentiful supply of oxygen is admitted, and if the combustion of the coke takes place on the surface, the tendency to form the lower oxide of carbon is at a minimum. However, when the carbon dioxide is forced through the coke itself by reason of its porosity, the tendency to form carbon monoxide is very great. The reason of this reaction is to lower the temperature, as two-thirds of the heat that the coke is capable of yielding is lost, at any rate, so far as the hot zone of the cupola is concerned, when carbon monoxide is formed.

"The calorific intensity of coke under ordinary cupola conditions, is about 1,700 degrees Cent., and in practice, 1,500 degrees Cent. may be obtained. It will readily be seen, that if two-thirds of the heat units a portion of the carbon of the coke is capable of generating are taken away, the temperature must fall considerably. This phenomenon is best observed under crucible melting conditions, and the results of tests with three varieties of coke are interesting. Under the first crucible a new coke was used, but it was found impossible to maintain a temperature sufficiently high to melt the charge. The other two were tried in adjacent holes. One of these cokes, when fractured, was decidedly dark in color, but less porous than the others. This was far superior to the other coke in maintaining the necessary temperature. The best of these cokes showed an intense temperature, while the worst grade showed a uniform temperature, but too low to melt the charge; the third coke gave an intense heat, but when poking it down it had become decidedly soft. In these cases the amount of carbon monoxide was the factor which caused the variations in temperature. It should be remembered, however, that each of these cokes had about the same calorific value."

R. BUCHANAN
Member Council, B. F. A.

R. W. KENYON
Member Council, B. F. A.

W. F. BAGNALL
Member Council, B. F. A.

CHARLES JONES
Member Council, B. F. A.

W. H. SHERBURN
Member Council,
B. F. A.

In the ensuing discussion, Herbert Pilkington pointed out that it was largely true that the practical man judged coke, rather by appearance than by chemical composition, but it was a mistake to suggest that founders do not give chemical analysis consideration. Regarding density of coke, he said that if a wheelbarrow of this fuel weighing 100 pounds less than another will do the same work it must be economical to use spongy coke, other things being equal. While density is a factor of importance, the question of phosphorus in the ash was a matter deserving investigation. F. J. Cook thought that Mr. Knowles rather underrated foundrymen in suggesting that they judged coke, rather by appearance than analysis. He believed that moisture is an important consideration and stated that some firms rigidly insist upon a low percentage of moisture and will only pay for a certain amount. With regard to density, he was of the opinion that a great saving could be effected if the coke bed could be made the same height with coke weighing 100 pounds less. However, the coke should be sufficiently friable and must be able to withstand the weight. R. Mason stated that it was a great mistake to grade coke by its silvery appearance, and from experience he was favorably impressed with by-product coke. Coke should be judged, not by appearance, but by its success in melting the metal. Mr. Mather cited an instance reported to him, of a concern which used coke containing 10 per cent moisture, and less fuel was required than when the moisture was low. Regarding this, R. L. Rhead said that the good effect of moisture might be due to the action in retarding the heating of the coke. Correct conclusions, however, can only be obtained from experience, which would show whether water in coke was desirable or not. He suggested that this was a proper subject for research by the association. Mr. Dowding, Fuima, Austria Hungary, reported an experience he had with coke, shipped perfectly dry to Austria Hungary from Cardiff. In using it for heavy castings he was unable to obtain a sufficiently

SNAPPED AT ONE OF THE MEETINGS OF THE B. F. A.—J. E. H. ALLBUT, SECRETARY, IS STANDING AT THE RIGHT

BRITISH FOUNDRYMEN ON THE STEPS OF THE MUNICIPAL SCHOOL OF TECHNOLOGY

First row, left to right—F. W. Finch, R. Buchanan and Herbert Pilkington.
Second row, left to right—R. W. Kenyon and Mr. Henderson.

hot metal, although the furnace appeared to be working satisfactorily. A heavy thunder storm soaked the coke and thereafter he obtained better results. While he was unable to state the percentage of moisture, his experience served to show that moisture was beneficial.

Cupola Slags.

A paper on "Cupola Slags", presented by Thos. Swinden, is presented in abstract as follows:

While the study of slags has received considerable attention, cupola slag, notwithsanding its importance in the gray iron foundry, has not received the recognition it deserves. The foundryman treats his charge so as to flux off the coke, ash, sand, and dirt, and his additions of flux are made according to the flow and appearance of the slag. Cupola slag must be fluid enough to run cleanly from the slag hole. This depends upon both composition and temperature, and a higher temperature usually renders a slag more fluid and more chemically active. The fluidity of the slag is almost entirely a question of flux, although an excess of flux may mean both damage to the lining, and loss of iron. In the accompanying table are given the analyses of a series of slags, the first from a cupola melting No. 2 foundry iron, and using approximately 50 per cent of new metal. The composition of the iron was as follows: Silicon, 2.25 per cent; manganese, 0.80 per cent; sulphur, 0.035 per cent; phosphorus, 0.045 per cent; combined carbon, 0.50 per cent and graphitic carbon, 3.50 per cent. Limestone was added to the extent of about 1¾ per cent of the iron. Slag No. 1 was taken when the slag was running very thick; No. 2 was a good, medium, and No. 3 was taken when 3 per cent of limestone was used, and was very thin. The coke analyzed as follows: Ash, 6.35 per cent; sulphur, 1.11 per cent; moisture, 1.30 per cent; fixed carbon, 91.24 per cent. It will be noted from the table that as the slag is thinner, so the iron content increases, and the silica has a tendency to fall. While the lime is lower in the thin sample, in spite of the fact that more limestone was charged, alumina steadily increases. The explanation would appear to be, that in No. 1 there was either insufficient limestone, or the temperature was too low for the lime to react and to form, together with the alumina and iron oxide, a very fluid slag. The thin slag is almost a black glass, which is characteristic of the slag just after a limestone addi-

Sample No.	Melting.	Analyses. SiO_2.	Al_2O_3.	FeO.	MnO.	CaO.	CaS.	MgO.	*Appearance.	Streak (or color of powder).
		METAL SLAGS.								
1	Thick	50.05	4.68	14.97	2.23	27.42	0.110	0.43	Hard, crystalline, stony center; glassy exterior; glassy, dark greenish brown.	Dirty, greenish brown.
2	Medium	44.0	5.01	15.55	3.07	31.92	0.120	0.36	Slightly spongy on top; dense, glassy, of brownish green tint.	Light, brownish green.
3	Thin	44.6	5.52	21.51	2.67	24.53	0.110	0.43	Dense, glassy; easily splintered; dark olive green.	Brighter green.
4	Thick	54.36	1.32	5.76	7.20	23.60	0.031	0.81	In transmitted light deep brown; interior shows bluish green.	Light, grayish brown.
5	Medium	62.50	7.02	12.97	8.37	7.98	0.033	0.89	Dark olive green in transmitted light; direct light shows mixture dark brown and dark olive green.	Light, greenish brown.
6	Thin	51.40	8.36	20.84	7.56	11.18	0.030	0.44	In transmitted light greenish brown; direct light shows interior rather dark olive green.	Dark, greenish brown.
		SPIEGEL SLAGS.								
7	.....	41.00	6.19	1.75	39.06	11.62	0.58	—	Dark brown, heavy, inclined to be stony, crystalline of light greenish brown tint; exterior deep chocolate brown.	Light brown.
8	.....	44.60	6.27	2.84	29.46	16.80	0.58	—	Very much lighter in color; very spongy.	Very pale brown.
9	.....	50.05	10.80	0.62	22.86	15.10	0.414	—	Light, porous, and almost pure meerschaum color.	Pure, creamy-white.
10	.....	33.00	5.85	6.05	16.56	36.45	1.45	0.80	Heavy, stony, crystalline; deep chocolate brown.	Brown.
11	.....	34.60	5.68	6.23	10.70	38.59	3.25	0.82	Denser than 10; color more grayish tint; surface shows "manganese brown."	Grayish brown.

*Samples caught and cooled in iron mold giving sample 3 x 2 x 2 inches.

MEMBERS OF THE B. F. A. ON THEIR TOUR OF INSPECTION OF THE SHOPS OF THE LANCASHIRE & YORKSHIRE RAILWAY CO.

tion. Slags Nos. 4, 5, and 6 form a supplementary series from a cupola melting iron for Bessemer blowing. It will be noted that there is a steady increase in the iron content, as the lime decreases.

Acid-Lined Cupola.

The results of experiments with a cupola lined with an acid lining melting spiegeleisen are also given. This metal had the following composition: Carbon, 4.50 per cent; manganese, 11.50 per cent and silicon, 0.75 per cent. Limestone to the extent of 2 to 3 per cent was used as a flux. It was found that when the flux is not working well, or if the cupola is cold, the slag is brown, heavy, and is inclined to be stony. The manganese oxide of slag No. 7 is nearly 40 per cent, as a result of a comparatively cold cupola, while slag No. 8 from the same cupola, a few hours later, after a double dose of limestone, shows a reduction of the manganese oxide to practically 30 per cent, and the slag was lighter in color, porous and spongy. No. 9 is considered an ideal slag. It is light, porous, and of a pure meerschaum color and pumice-like in appearance. The manganese oxide is only 22.86 per cent. An interesting feature is the formation of a lime-manganese-silicate, while the iron oxide is very low. The analysis of the remelted spiegeleisen follows: Carbon, 4 per cent; manganese, 10 per cent; silicon, 0.06 per cent. The loss of manganese was about 15 per cent.

An interesting comparison of these results is furnished by slags Nos. 10 and 11. These are from the same cupola, with a basic lining, melting similar spiegeleisen, which analyzed as follows: Carbon, 4.5 per cent; manganese, 12 per cent; silicon, 0.75 per cent. The flux was limestone, with a little fluor spar. The manganese oxide was considerably lower than when melted in an acid-lined cupola. Both lime and iron are higher, while the silica is lower. The slag is more basic in character and as a result the basic manganese oxide is not so easily formed and fluxed off. The remelted spiegeleisen showed a loss of about 6 per cent of manganese.

Color of Slags.

The question of the color of slag is an interesting one, and the following notes are not as advanced as exhaustive, but rather as an approximate guide:

Iron Oxide (FeO).—In the first stages grass green, changing through grayish-green to brown, and finally almost to black.

Manganous Oxide (MnO). — Yellow to brownish-green, changing to yellow-brown. When very high, deep brown.

Alumina (Al_2O_3). — Excess tends to produce opalescence, and to keep a slag vitreous.

Lime (CaO).—By virtue of its basic nature, tends to give a dull, stony slag when very high.

Vanadic Oxide is said to produce a bluish slag.

Titanic Oxide in stony slags gives a peculiar purplish-gray, while in glassy slags it may be brown or violet.

The sulphides have a strong influence. Manganese sulphide gives yellowish to brownish-green; ferrous sulphide, dark brown to black. The presence of two or more of these compounds render it difficult, except, perhaps, in any particular line, to say definitely what the color shows. The presence of much iron and manganese together makes a very dark slag, but the difference in the greens, when apart, is quite clear.

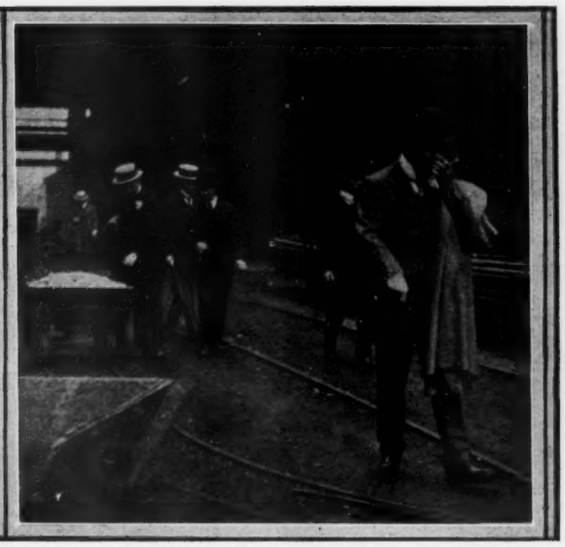
Discussion of Cupola Slags.

Mr. Mather, opening the discussion, pointed out that slags showed remarkable differences in the content of ferrous-oxide. In one case it reached 15 per cent, which indicated a very considerable loss of iron in the cupola. R. Buchanan said it was commonly supposed that the more lime used, the lower the iron content in the slag would be. He had made various tests with lime without being able to make any satisfactory deductions. It was stated that approximately 39 pounds of limestone per ton of iron was the proper amount to use, although he said 20 to 28 pounds of lime per ton of iron is sometimes employed. Mr. Swinden said that the question of iron content depends upon the varying working conditions, as well as blast pressure. Examples reported in this paper did not suggest any definite relationship between lime and iron. The black color of the slag is generally due to an excess of iron, and a brown color indicates manganese.

Wednesday Morning.

The first paper presented Wednesday morning, entitled "The Cupola," by R. Mason, dealt with the construction and operation of this melting medium. R. Buchanan, opening a lengthy discussion, agreed with Mr. Mason that it was impossible to give definite quantities of limestone to be used, in view of the various methods of cupola operation practiced. Some time ago a coke salesman expressed to him a regret at the large amount of lime his fuel contained. In reply he pointed out that limestone might be a recommendation, as it would reduce the amount of lime to be used as a flux. This fact would not be recommended, however, if the coke had to be used for steel crucibles. A coke containing 20 pounds of lime to the ton is largely self-fluxing. As to types of cupolas, he was quite certain that they had not yet reached the final form of the interiors. In the blast furnace it was possible to operate for a number of years without relining, whereas with a cupola, repairs must be made every day. During the past year Mr. Buchanan has been separating the slag from the final dump of the coke, and it has resulted

PERCY LONGMUIR, DELIVERING THE PRESIDENTIAL ADDRESS AT THE OPENING SESSION OF THE B. F. A.



BRITISH FOUNDRYMEN INSPECTING THE LOCOMOTIVE WORKS OF THE LANCASHIRE & YORKSHIRE RAILWAY CO.

in a considerable saving in that it eliminated hand-picking. He did not agree with the suggestion regarding the piling of a center column of coke in the cupola, which could only be done in a furnace of large diameter. The question of blast was one, he believed, that required attention. He agreed with the suggestion to reduce the air supply, but this involves a revolution in foundry practice, as the idea has previously been that a large amount of air is necessary. He found by-product coke to be the best notwithstanding the fact that it did not have as good an appearance as beehive oven fuel.

Tuyeres.

F. J. Cook said he preferred to have the tuyeres inclined downward. He added that there should be as little restriction as possible in the size of the blast, from the blower to the air belt. Regarding tuyere area, he found the best results were obtained with a size from one-twelfth to one-sixteenth of the tuyere zone. The testing of blast pressure he pointed out was a matter that also required consideration. He had considerable trouble with an electric motor in which the voltage dropped considerably in the late afternoon. Under such circumstances the blast pressure might be easily doubled. Blast observations had been vitally important at the works of his firm, where they were compelled to meet the most varied requirements. He agreed with Mr. Mason that it was dangerous to specify the exact amount of blast pressure for certain work, as the results depend largely on the character of the cupola.

Mr. Penlington asked for suggestions as to the different methods of fluxing. He said that he had installed a cupola, 15 inches in diameter, known as a "baby" furnace, in which iron was melted with five ounces pressure. Eventually, 2,500 pounds of iron were melted in this cupola three times a day with good results. Mr. Smith said he was not greatly in favor of two rows of tuyeres. He said he had seen very good results obtained with tuyeres of rectangular shape and semi-circular ends.

Replying to the discussion, Mr. Mason said that for cupolas of any size the limestone should be well broken down, to ¾ inch if possible. Too little limestone is generally used, but coke containing as high as 20 pounds lime per ton should be avoided. He believed it essential to record the blast pressure so as to ascertain the work of a furnace hour by hour. As to the form of tuyeres, he believed that they should be inclined downward slightly. As to the suggestion that air should enter high up, he had found no advantage from this practice and the coke consumption was not reduced. He said that it was obvious that irregular blast interfered with the melting of the metal and that the best results were secured by uniform blast pressure. He understood that fluorspar is used extensively in America.

Theory of Malleablizing.

W. H. Hatfield discussed the "Theory of Malleablizing," which is presented in part herewith:

The mechanical arts owe much to the comparatively low melting and freezing point of cast iron, since castings of even the lightest and most difficult configuration can be made with ease at a little cost. Such castings are of variable strength, do not offer much resistance to shock, and are practically devoid of ductility. Early in the eighteenth century it was found that by annealing some kinds of cast iron, a very ductile material could be produced. The two distinct systems of malleablizing were compared; the first is known as the Reaumur, or European process, and the second is known as the American, or blackheart process. The Reaumur process depends upon the principle of decarburization. As cast, the material is intensely hard and microscopically consists largely of the hard constituent, cementite or carbide. This constituent must either be eliminated or destroyed before the casting can acquire the property of malleability.

Changes During Annealing.

Experiments, indicating the actual changes taking place during the annealing process, were recorded. The analysis of the castings used was typical of that employed by most producers of this material, and was as follows: Combined carbon, 3.5 per cent; manganese, trace; silicon, 0.50 per cent; sulphur, 0.35 per cent; phosphorus, 0.05 per cent. Samples were taken from the furnace at various stages of the annealing process, the castings having been packed with iron ore. Micro-sections were prepared from each test piece, and in this manner the progressive changes were observed. At approximately 750 degrees Cent., and after 50 hours annealing, practically the whole section consisted of the cementite-pearlite structure, but a thin skin was apparent from which the carbide had been removed.

At approximately 825 degrees Cent., and after about 65 hours annealing the micro-section was almost identical with the former, except that the decarburized skin was increasing in thickness.

At 900 degrees Cent., and after 80 hours annealing, the skin was much thicker, and was seen to be outwardly composed of ferrite, which changed gradually to pearlite, after which the

THE PRESENTATION OF A GOLD WATCH AND PENDANT TO TREASURER, F. W. FINCH

PERCY LONGMUIR, PRESIDENT-ELECT OF THE B. F. A., AND F. J. COOK, HIS PREDECESSOR, AT THE RIGHT

cementite of the hard interior was reached.

At about 975 degrees Cent., and after 95 hours annealing, the skin was still thicker and the decarburization had penetrated at least 3/16 inch, but the micro-structure was little altered otherwise.

The temperature of the furnace was then permitted to fall slightly, to about 975 degrees Cent., and after 125 hours annealing, a micro-section showed that a great change had taken place. The cementite in the central portion had disappeared entirely and was replaced by a matrix equivalent to high-carbon steel.

With the temperature practically unchanged and after 165 hours annealing, there was little further change except that the decarburization proceeded further toward the center of the bar and the annealing carbon appeared gradually to decrease in size.

The furnace was opened after 220 hours and when the temperature had fallen to 600 degrees Cent. The center of a micro-section at this stage consisted of well-laminated pearlite, containing the annealing carbon and which merged into the well-developed ferrite of the skin. The final material analyzed as follows: Combined carbon, 0.65 per cent; annealing carbon, 1.10 per cent; sulphur, 0.35 per cent; phosphorus, 0.05 per cent.

Theory of Annealing Process.

During the annealing, two distinct processes were at work, namely elimination by oxidation, and softening by the precipitation of annealing carbon. The feature of interest is that the decarburization was the first phase of the change, while the breaking down of the carbide was a later development.

As a result of these and supplementary experiments, the author expressed his views of the chemical physics involved as follows: "The carbon is eliminated while still in combination with the iron. At the comparatively low temperature of 750 degrees Cent., this reaction begins to take place between the carbide of iron and the oxidizing medium. The activity of the elimination gradually becomes greater with the increase in temperature until a temperature is reached at which the precipitation of annealing carbon takes place until equilibrium for that temperature is established. After precipitation, there is still a decarburized exterior, but in the center, a composition equal to saturated or slightly supersaturated steel, in which the precipitated temper carbon is contained. The carbon now in solution appears to diffuse outwardly to the skin to replace the carbon previously eliminated. In this manner further combined carbon is removed from the iron and the equilibrium is maintained by the absorption or solution of more annealing carbon to fill its place."

American Process.

The American blackheart process is somewhat different although in principle there is more similarity between it and the Reaumur process than is at first apparent. The composition of the American irons are such that the carbon can consistently be precipitated with more completeness, and the result is the well-known black fracture of the castings. The steely appearance of European malleable iron is due to the retention of a small percentage of the carbon in combination. Tests previously made by the author to ascertain the reactions of the blackheart method indicated that they do not depend upon the principles of decarburization. The castings were heat-treated in a large annealing oven and test bars were taken at different periods. The micro-section of a sample taken when approaching 800 degrees Cent., indicated that a slight diffusion of the cementite had already taken place. Another sample taken some hours later, at 820 degrees Cent., showed that the precipitation had already commenced, but after another 48 hours it was found that most of the carbide had been broken up. After completing the heat treatment and cooling down to 750 degrees Cent., it was found that the whole of the carbide of supersaturation had disappeared. It was concluded that as the bar only contained ferrite and annealing carbon, the carbide of the pearlite must have decomposed immediately upon a resolution of the latter. The analysis of the annealed castings follows: Combined carbon, 0.05 per cent; annealing carbon, 2.60 per cent; manganese, 0.14 per cent; sulphur, 0.06 per cent; phosphorus, 0.04 per cent; silicon, 1.10 per cent.

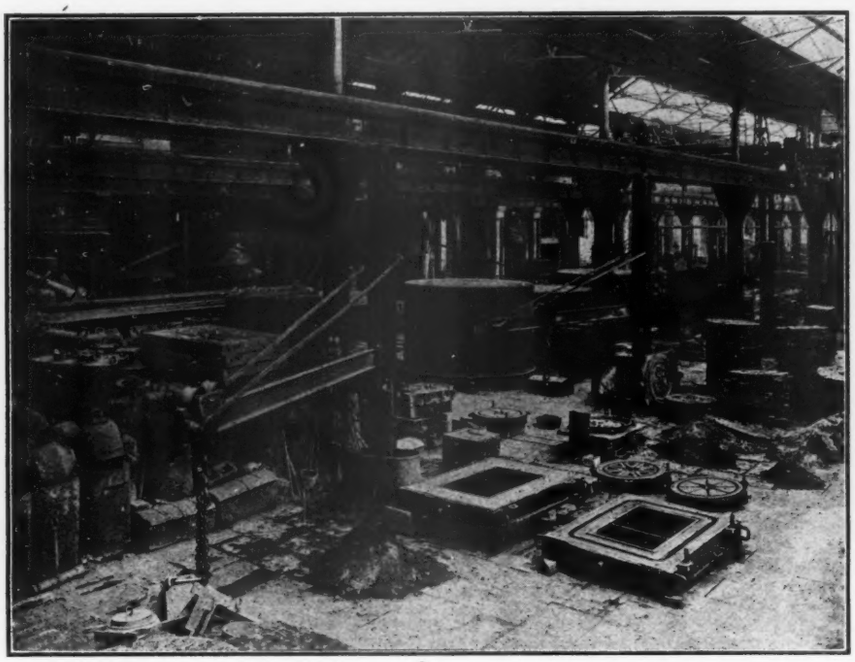
Discussion of Malleable Iron.

R. Buchanan called attention to the large amount of sulphur which appeared to be in the iron produced under the Reaumur process. He believed that by the blackheart process, malleable castings could be more easily made. He also added that it was quite refreshing to find makers of malleable iron at last coming forward with information regarding their methods. Replying to the discussion, Mr. Hatfield pointed out that contraction differs very much in heavy and light castings. With blackheart material it is about ¼ inch per foot and, when annealing, it is customary to allow half the distance between the original size and the pattern. In other words, if the founders take about half the distance between the size of the pattern and the castings, they would about hit the blackheart shrinkage. Considerable difficulty is also experienced as a result of over-annealing. Castings made by the blackheart process showed a tensile strength of from 40,000 to 50,000 tons per square inch, and these castings also showed better test results under shock.

The Electric Furnace.

The following paper on "The Electric Furnace" was read by W. S. Gifford:

The electric steel furnace has been



GENERAL VIEW OF THE LANCASHIRE & YORKSHIRE RAILWAY CO.'S STEEL FOUNDRY

causing so much interest of recent years, and so many papers and articles have been written about it, that it is difficult to say anything original on the subject. There is one of its uses, however, which has been comparatively neglected in the technical literature of the day, although it is of great importance, and has been considerably developed in practice. I refer to its application for making castings.

The use of the electric furnace in the foundry has long since passed the experimental stage, and British foundrymen must now consider it as a process which is accepted on the continent, and with which they must reckon in England in the near future. It has been, to some extent, assumed in this country that it can only be economically adopted in places where the proximity of water power makes electricity extremely cheap, but it must be remembered that cheap power is less important to the steel maker than accessibility, and the two are seldom found together.

Heroult Furnace.

The various types of electric furnaces have been described so often that it would serve no useful purpose to go over the ground again. I will, therefore, only take one furnace which has been widely adopted in England, America and on the Continent, and mention some of its many points. The Heroult furnace is not a complicated electrical contrivance, but a simple, tilting, basic open-hearth furnace in which the heat is applied by electricity instead of by some fuel which is bound to introduce sulphur and gas. The bottom is lined with dolomite, and the roof with silica, and any man who can line a basic furnace can do this work on the electric furnace. The electrodes are moved up and down by an automatic regulator, and consequently there is very little labor required.

TROPENAS CONVERTERS IN THE LANCASHIRE & YORKSHIRE RAILWAY CO.'S STEEL FOUNDRY

Cost of Repairs.

The cost of repairs is very low. The roof lasts from 100 to 130 heats for refining molten steel. The cost of repairing a roof for a 2½-ton furnace is £3, which amounts to about 2½d per ton of steel. The bottom is merely fettled with dolomite between the heats, the total cost for refractories being about 6d per ton. These figures are obtained from South Chicago, where a 15-ton furnace has been in steady operation for 15 months, refining molten steel from a Bessemer converter and turning out about 15 heats every 24 hours. The electrode consumption amounts to 6 pounds per ton in large furnaces, and 10 pounds in a small furnace in Germany, which, at 2d per pound (the cost of manufacture being less than 1d) is equal to from 1s to 1s 8d per ton of steel. The idea, by the way, that with an arc furnace it is impossible to make a low carbon steel owing to the carbon from the electrodes getting into the metal is quite erroneous. There is no difficulty at all in keeping the carbon contents down to 0.03 per cent.

In places where the cost of power is high enough to make its consumption a matter of prime importance, the most economical method is to take molten and dephosphorized steel from a basic-lined furnace, preferably of a tilting type, and remove the gases and sulphur in the electric furnace. Even when using the commonest raw materials the sulphur can be brought down to below 0.02 per cent and the gases completely removed in the Heroult furnace for a power consumption of from 100 to 150 kilowatt hours per ton, which, at a rate of 0.6d per unit, works out at from 5s to 7s 6d per ton. This expense, together with that for labor, repairs, electrode consumption, etc., can, as a rule, be more than counter-balanced by the saving in the cost of raw materials. The complete deoxidation is an especially important point, which is not generally sufficiently recognized.

Melting Process.

Where power is cheap the whole process of melting and refining can be performed in the electric furnace. The procedure is then very simple. Lime and mill scale or iron ore are put in first, and scrap is added. The slag gradually works its way upward through the scrap, and by the time the steel is melted the phosphorus is removed. This oxidizing slag is then skimmed off and the sulphur is removed by a basic slag. This slag is extremely basic and falls to pieces after teeming. The extreme reducing atmosphere of the furnace at this stage is shown by the fact that pow-

dered charcoal put on the surface of the slag remains unburnt for a long time.

The arc on the lime slag forms calcium carbide, which in its nascent condition is very active in combining with sulphur. The presence of calcium carbide can be proved by putting a piece of slag in water, when a strong smell of acetylene is given off and the slag is seen to be white in color.

Fluidity of the Steel.

The power required for melting and refining common scrap to 0.02 silicon and phosphorus, in this way, is about 750 kilowatt hours per ton. For intricate castings the great fluidity of the steel, owing to its complete deoxidation, is very advantageous. Castings of less than 1/25 inch in thickness have been made in Germany for aeroplane radiators. Another point is that the amount of gates can be decreased. Owing to the extreme reducing atmosphere of the furnace the addition of numerous deoxidizing agents and other sorts of physic are avoided, so that more homogeneous castings are made, and there are fewer wasters and blowholes. The product obtained, either by melting cold scrap or refining open-hearth steel is of the quality of good crucible steel, so that the advantage of the electric furnace over the open-hearth is that it produces a superior steel for the same price.

Comparison With Crucible Process.

In comparison with the crucible process the gain of the electric furnace is one of cost. In this case there is a very large saving when making castings, as the cheapest raw materials can be used.

For the manufacture of heavier castings, where the margin of profits is much smaller, each case requires careful individual consideration. A short refining process in the electric furnace may often be adopted advantageously, more for removing the gases, and consequently increasing the fluidity, than for obtaining extreme purity of chemical analysis. In such a case complete deoxidation with partial refining can be obtained for about 100 kilowatt hours per ton. The cost of this treatment is often counter-balanced by the smaller proportion of wasters, and the decrease in the number of gates and runners.

Discussion of Electric Furnaces.

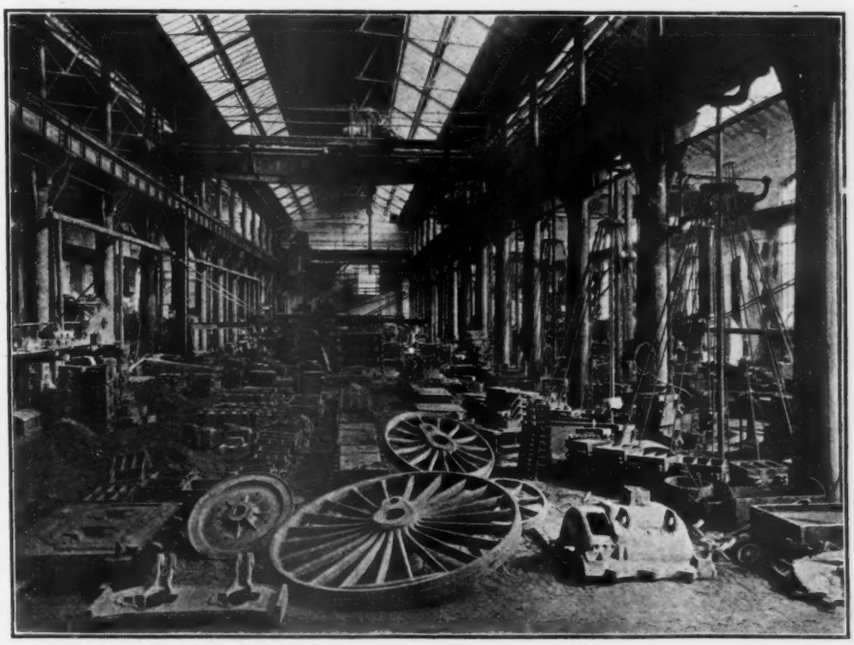
In opening the discussion, the chairman said that there was no subject which the iron founders should devote more attention to than that of electric melting. Hundreds of tons of castings are being shipped into England melted from Continental steel, and the electric process in these foundries has already proved a success. F. J. Cook said that he could understand that the electric furnace would be very valuable for such things as cylinders, and he asked whether this method was applied to gray iron, and whether in any instances, it could be used for that purpose. W. H. Hatfield pointed to an obvious advantage in the electric furnace, as foundrymen are not compelled to mix the material, but he did not believe that the electric furnace, commercially, was better than the open-hearth, or the crucible. Mr. Campbell contended that manufacturers were not quite satisfied with converter and open-hearth steel and he believed that there must be some reason why so many on the Continent were now adopting electric furnaces. The chairman said that he had recently been on the Continent, where he had seen many electric furnaces in operation and it was surprising that Sheffield steel manufacturers sent representatives to Italy, Germany and other countries to study these furnaces. Mr. Campbell said that he was not aware that the electric furnace had been used commercially for making gray iron castings. At the present time eight furnaces are under construction in Great Britain.

JOURNAL BOX MOLDING MACHINE IN THE FOUNDRY OF THE LANCASHIRE & YORKSHIRE RAILWAY CO.'S PLANT. ONE OF THE TURNTABLES ON WHICH THE MACHINE-MADE MOLDS ARE CAST IS ALSO SHOWN

Brass Alloys.

"The Constitution of the Brass Alloys" was the subject of a paper presented by O. F. Hudson, of which the following is an abstract:

The alloys which are grouped under



GENERAL VIEW OF THE GRAY IRON FOUNDRY OF THE LANCASHIRE & YORKSHIRE RAILWAY CO.

the general title of brass are composed of copper and zinc, and constitute the most important series of the non-ferrous alloys. They vary widely in composition and include a large number of well-recognized mixtures, known as common brass, yellow metal, Delta metal, etc. The metals forming an alloy may exist in three conditions, namely: In a pure or practically pure state; in the form of a solid solution, or as a chemical compound, which also may be dissolved in a state of comparative purity, but the other metals, copper, zinc, tin, etc., cannot be distinguished in any part of the alloy, as they merge in the solid solution and form perfectly uniform mixtures from which the component substances cannot be separated by mechanical means. Many metals are capable of forming true compounds with each other, which are mostly hard and brittle, and alloys containing such metals generally consist of mixtures of such compounds and a solid solution consisting of the other excess metals. More than three separate and distinct substances can never exist together in any series of alloys consisting of any two metals under normal conditions, and then only at a definite temperature in an alloy of definite composition, as in the case of the freezing or melting of a eutectic. When the alloy consists of more than two metals, the number of substances that can coexist in it in a state of equilibrium becomes larger, the maximum being one more than the component metals.

Alloys of Three or More Metals.

The constitution of a series of alloys of three or more metals is usually very complex, and has been little studied. An alloy of copper and zinc containing more than 70 per cent copper, consists, when completely solid, of a single phase solid solution of zinc in copper, which will be known as *A*. Such alloys, when examined microscopically, after being polished and etched, are seen to have an arborescent structure caused by cores slightly richer in copper than the rest of the solution, in each of the crystalline grains. A long annealing will make a solution of perfectly uniform composition throughout, the cores will disappear, and the microscopic structure will be one of homogeneous crystal grains with very irregular boundaries. The same uniformity of composition is more quickly realized if the alloy is rolled before annealing. When the alloy contains less than 70 per cent copper, it consists of two solid solutions, *A* and *B*. The latter is also a solid solution of zinc in copper, which at ordinary temperatures, may contain between 51 and 53.5 per cent of copper. When cold it is much less malleable and ductile than the *A* solid solution, but is fairly malleable when hot.

The *B* solution, when examined microscopically, shows no cores in the crystals, due to the lack of uniformity in composition. The properties of the *B* solution are quite distinct from those of the *A* solution, and alloys containing mixtures of *A* and *B* are particularly suitable for hot rolling, as they are more malleable when hot than when cold. When tin is present in such alloys it seems to be dissolved by both *A* and *B* up to 1 per cent, increasing the hardness of the brass without impairing its malleability, and makes the alloy better able to resist corrosion under certain conditions. A good illustration of this class of alloys is naval brass, which contains 60 to 62 per cent copper, 1 per cent tin and the balance zinc. When tin is present in excess of 1 per cent, it gives rise to a separate constituent, which is seen under the microscope as a light blue material. This is hard and brittle, and probably consists of the formula $Cu_4 Su$.

Lead.

Lead is not held in a state of solution or combination in the solid alloy, but is present in the free condition, and can be recognized under the microscope as small round particles or streaks. Owing to its low melting point, the lead remains fluid after the rest of the alloy has solidified, and tends to form a film or layer around the brass crystals, thus impairing its strength and malleability. Lead, however, serves the useful purpose of improving the turning qualities of the alloy, but with more than 2 per cent of lead the alloy is difficult to roll. Alloys such as Delta metal, Sterro metal, Durana metal and manganese bronze, usually contain between 55 and 60 per cent of copper, with 1 or 2 per cent of iron and sometimes small amounts of aluminum and manganese. The iron, aluminum and manganese enter into solution, and the alloys consist of *A* and *B*, in which *B* predominates, or practically excludes *A*. Brasses of this character have often exceptional strength and toughness as well as resistance to corrosion, and are being increasingly used.

Mr. Buchanan said he would like to know something about the non-contracting brass produced at the Birmingham University. R. L. Rhead pointed out that the micrographs accompanying this paper had shown the enormous value of the microscope. Mr. Dowding called attention to the great difficulties experienced by foundrymen away from large centers of manufacture. When he used the microscope he found it difficult to arrive at a definite conclusion. Copper, he said, he found very awkward to deal with satisfactorily. Mr. Hudson briefly replied to these remarks. He stated that dealing with brass alloys was a matter of great complexity and that there was no doubt that dissolved gases and dissolved oxides had a great influence on the resultant product.

Hardness Tests of Cast Iron.

Richard Mather presented the following paper on "The Hardness Testing of Cast Iron:"

The testing of hardness is still perhaps in a more unsatisfactory state than that of any other of the important properties of metals. This is due largely to the fact that there are several forms in which hardness manifests itself, and that there is no method by which all these forms can be measured in one test. Moreover, the property most often in question in actual practice in connection with hardness is what Keep calls "workability," that is, ease of machining in a casting, or durability in a tool; and this is a function of the tenacity as well as of the true or "mineral" hardness.

Definition of Hardness.

The usual definition of the hardness of a body as the resistance it offers to penetration does not at once suggest an obvious and direct unit such as, for example, the number of tons per square inch, by which tensile strength is expressed. As a consequence of this, there is some diversity of opinion and practice among those who have put forward methods and instruments for measuring hardness. It is to be hoped that there will gradually come about a clearer understanding of the principles on which hardness determinations should be based. Once there is a general agreement on this point, the advent of a satisfactory method and instrument will not be far off.

In the iron foundry, hardness is not often deliberately sought; in most cases the necessities of machining, etc., require that it shall be avoided, and even where this is not of importance, the properties desired in the casting are often inconsistent with great hardness. Therefore, the number of cases in which hardness is aimed at for its own sake in the foundry is comparatively small, and in these it is almost always abrasion hardness—resistance to wear—that is required. This somewhat simplifies the hardness-testing of cast iron as contrasted with steel, where in one case cutting hardness, in another elastic hardness, in a third abrasion hardness, and so on, may be demanded. But cast iron has the complication that the hardness varies considerably from the surface of the casting inwardly. It is the chief advantage of the Keep test that it does not ignore this variation.

Hardness of Cast Iron.

It is a common-place in the foundry that the hardness of cast iron varies with the openness of the fracture, with the shrinkage and contraction, and in a general way with the tensile or transverse strength. Where the hardness or softness in itself is immaterial, but where it is important that there shall be, for instance, little shrinkage, the foundryman will usually say, not that he wants a low shrinkage or high silicon or low sulphur iron, but that he wants a soft iron. I think that this tendency points the chief direction in which we in the foundry may find hardness tests useful. We shall probably find, each in his own particular circumstances, that the hardness bears a close relation to some property or other which is important in each different class of work.

The hardness of cast iron depends chiefly upon its content of combined carbon, and also on the silicon (regarded independently of its influence on the state of its carbon). The hardness rises or falls as each of these elements rises or falls. The relations of the carbon and silicon contents of

cast iron to its other properties have been so often dealt with that there is no need here to trace in detail the relations between the hardness and these other properties. The conditions of cooling affect the hardness chiefly through the carbon.

Uniformity of Tests.

When one turns from the general desirability of testing hardness to the actual carrying-out of the tests, several difficulties occur. An ideal test should express the results in terms of the ordinary units of length, mass, and if necessary, time, so that the figures should be comparable with those obtained elsewhere under different conditions and with a different instrument. The test should be accurate, quick, sensitive to small variations, and easily applied; and the instrument should be portable so that it could be used on a large casting, which should not be damaged or defaced in the operation. But present methods fall a long way short of this perfection.

The oldest test, and by far the commonest, the file test, does not need any explanation. Its possibilities, advantages and limitations are well enough known. Like most other tests which depend so largely on the personal factor, it is gradually being superseded where accurate knowledge is desired.

Hardness Testing Instruments.

Of the more exact methods introduced in the last 25 years, Prof. Turner, in his useful summary* of the present position of hardness testing selects for comparison four which are typical of nearly all that are in general use. To three of them I shall refer only very briefly.

Turner's Sclerometer.

Prof. Turner's own method consists in noting the weight with which a diamond point must be loaded to produce a standard scratch on a polished surface of the metal. This test corresponds with that of the ordinary mineral scale more nearly than any of the others. It is easily applied by the instrument called the sclerometer, but as he notes† "some skill is required in determining the standard scratch."

Keep's Test.‡

This is carried out in a way which makes it an excellent measure of the machining properties of the metal. The sample is drilled by a standard drill loaded with a constant weight and performing a constant number of revolutions per minute. An automatic attachment plots on a piece of paper the number of revolutions against the amount of penetration, and thus gives a line or curve inclined to the horizontal and at an angle which varies with the hardness. For the purposes of this test, Keep has designed a specially adapted drilling machine.

Brinnell's Test.§

The ball-pressure test has, during the last 10 years, received much attention. In its original form a hardened steel ball, of known diameter, was pressed into the sample by a known force. The pressure applied, divided by the spherical area of the indentation produced, i. e., the force required per unit area of indentation, gives a number which is a measure of the hardness, since the greater the hardness the greater the force required to produce a given penetration. Small machines for the ready application of this test have been introduced, and are in use in many works. Prof. Martens considers that better results are obtained by using a cone instead of a ball and applying the force until a fixed depth of penetration has been reached, and by his machine the depth is measured simultaneously with the application of the load. A considerable drawback to this form of test is its inapplicability to finished castings.

Journal of the Iron and Steel Institute, 1909, vol. I.

†"Lectures on Iron Founding," p. 114.

‡"Cast Iron," by W. J. Keep, pp. 164 and 186.

§For full description, see *Journal of the Iron and Steel Institute*," 1901, I, p. 243.

The Shore Scleroscope.

This instrument was brought out a few years ago and seems already to have come into fairly wide use. A small hammer having a diamond point is made to drop freely from a given height on to the surface of the material, and the height to which it rebounds is taken as the hardness number. It seems that in a case of impact like this, the striking energy of the hammer (which produces a permanent indentation in the material tested) is used in three ways: (1) by the elasticity of the test piece and hammer; and (2) in producing the indentation; while what is left (3) produces the rebound. It is only the second portion which is truly proportional to the hardness, although Shore takes (3) for his hardness number. If the elasticity did not come into play, this latter would be a measure of the hardness, although the numbers would not be strictly proportional to the true hardness. But the elasticity cannot be ignored, particularly when widely different materials are being tested. This is very evident in the fact that a piece of ordinary rubber gives a rebound of about 50, ivory 45-50, and gray cast iron, which will easily scratch the ivory, a rebound of only 36.

The instrument seems somewhat to lack sensitiveness in dealing with gray irons. Castings, very soft to machine, have a hardness number 30, while those which the machinists find quite hard give only 36 or 37. I have only once had a casting give more than 38; it was mottled and had a hardness 48-54. A bigger range would be much more useful.

Scleroscope Tests of Cast Iron.

The following table of typical results shows the hardness of several cast irons in relation to the composition and mechanical strength; after the test bar (2 x 1 inch x 3 feet centers) had been broken in the transverse machine, a portion was ground on the side and tested in the scleroscope:

Hardness Number.	Deflection Inches	Graphite, per cent.	Combined carbon, per cent.	Silicon per cent.	Manganese, per cent.	Sulphur, per cent.	Phosphorus per cent.
38	0.36	2.88	0.49	1.77	0.37	0.083	1.26
37	0.35	2.80	0.25	1.82	0.56	0.083	1.16
36	0.35	2.65	0.53	1.96	0.34	0.090	1.25
*36	——	2.99	trace	2.70	0.35	0.060	1.6
35	0.35	2.89	0.24	2.64	0.32	0.112	1.6
33	0.35	2.91	0.21	2.55	0.29	0.114	1.6
31	0.34	3.01	0.15	1.99	0.54	0.075	1.6
30	0.37	2.92	0.34	2.15	0.35	0.071	1.6

*This sample was a portion of a casting and not from a test bar.

Comparisons of the various methods show a fairly general agreement if certain limitations are recognized and observed, but there is still too much uncertainty of principle and method in hardness testing considered as a whole, and too many discrepancies in the results to be really satisfactory, although if one keeps to a single material such as cast iron, the results obtained by any one method appear to have some real value for comparison among themselves.

President Longmuir announced that owing to an accident, G. Blume, of Sweden, was unable to attend. A cablegram expressing the sympathy of the members of the organization was sent to Mr. Blume.

Visits to Works.

On Tuesday afternoon the members visited the extensive locomotive works of the Lancashire & Yorkshire Railway Co., located at Horwich, which is only a short distance from Manchester. This plant covers 22 acres, and includes steel, iron and brass foundries, as well as a large blacksmith shop and rolling mill. The steel foundry is 150 feet long, and the melting equipment consists of both open-hearth furnaces and converters. The iron foundry is 202 x 111 feet. The brass foundry is 164 feet long, and the core ovens are heated with the waste gases from the brass furnaces. The erecting shop is 1,520 feet long and is one of the largest of its kind in England. This company also makes a specialty of gears for electric railways. Of the 250 in use during the period of six years only 21 had to be renewed and the average mileage was 48,500 per annum. The shop is well equipped throughout with molding machines for various classes of work.

On Wednesday afternoon the foundrymen visited the plant of Tweedales & Smalley, Ltd., Castleton, near Manchester. This concern manufactures cotton mill machinery. The foundry is 408 x 252 feet, and approximately 300 men are employed. The equipment consists of four cupolas, two of which are 31 inches in diameter inside the lining, and the other two are 27 inches inside diameter.

THE FOUNDRY

Published monthly by

The Penton Publishing Co.

CLEVELAND

BIRMINGHAM, ENG.....Prince's Chambers.
BUFFALO.....932 Ellicott Square.
CHICAGO.....1328 Monadnock Block.
CINCINNATI.....11 Blymyer Bldg.
NEW YORK.....1115 West Street Bldg.
PITTSBURG.....510 Park Bldg.
SEATTLE.....942 Henry Bldg.

Copyright, 1910, by Penton Publishing Co., in the United States and Great Britain.

The subscription price of THE FOUNDRY is $1.00 a year in the United States and Mexico. To Canada, $1.50. To Great Britain, Eight Shillings. Single copies, 15 cents each. Back numbers, three months or more, 25 cents each.

Change of advertising copy must reach this office on the 10th of the month preceding date of publication.

The Cleveland News Company will supply the trade with THE FOUNDRY through the regular channels of the American News Co.

European Agents: The International News Company, Breams Building, Chancery Lane, London, E. C., England.

PAID CIRCULATION OF THE FOUNDRY

January, 1909	9,143
January, 1910	10,373
July	10,902
August	10,963
September	11,015

Entered as second-class matter at the Post-Office at Cleveland, O.

Contents

Finishing and Plating Brass Castings 1
Swedish Malleable Iron Practice 8
Inartistic Fillets—How to Avoid them 11
A Modern Steel Foundry 13
Molding Brass Axle Bearings for Electric Cars 15
Alloys of Nickel and Chromium with Cobalt 17
Blow-Holes in Aluminum Castings 19
Copper Castings of High Conductivity 20
Plumbers' Solder 20
Brass Mixtures for Fittings 20
Manganese Bronze 20
Iron in Bronze 20
Brass Crystallization 21
Flux for Brass 21
Brass Scrap Pile—I 21
Easy Lessons in Chemistry 23
Cylinder Mixture 24
A Burning-On Job 24
Convention of British Foundrymen 25
A Foundry Gold Mine 36
Trade Outlook 36
Exhibition Company 37
Book Reviews 37
Skimming Drosses 38
Fuel Oil Furnace 38
Preparing Core Sand 40
Jarr-Ramming Stripping Plate Molding Machine 41
Foundry Crane Installation 42
Crucible Steel Mixtures 42
Core Molding Machines 43
Briquetting Cast Iron Borings 43

A Foundry Gold Mine

That the foundry now takes rank with the gold mine as a profit-producing investment is indicated by a prospectus, recently issued by several promoters, to interest capital in their undertaking. A specialty was to have been made of automobile parts, these sections undoubtedly having been chosen on account of the comparatively high prices which they command. The daily profits were placed at $462.23, on an estimated output of 15 tons of gray iron castings, an average of over $30 per ton. Detailed estimates of the operating cost were not lacking, as the following will show:

17 tons iron	$17.50	$297.50
2 tons coke	5.00	10.00
2 tons sand	1.00	2.00
2 tons coal	3.00	6.00
40 molders	3.00	120.00
40 laborers	1.50	60.00
6 core men		15.00
1 engineer		2.50
1 patternmaker		4.50
1 carpenter		2.50
Flask material		2.50
1 office man		2.00
'Phone, telegrams		.50
Stamps and stationery		.50
Core material		4.00
Taxes, insurance and repairs		10.00
Sundry supplies		2.00
Sundry expenses		3.00
The two promoters as managers		10.00
		$554.50
6 per cent for losses		33.27
		$587.77
10 tons castings	$ 55.00	$ 550.00
5 tons cylinders	100.00	500.00
		$1,050.00
		587.77
Profit		$ 462.23

It will be noted that the output per molder is placed at 750 pounds. This will undoubtedly prove a revelation to foundrymen who have been wrestling with intricate motor car castings, and it is evident that a new type of highly skilled artisan has been developed for employment in this shop. The scale of wages for both the molders and laborers would indicate that these employes were to share in the profits, as the basis of compensation is one that prevailed in casting shops some 10 years ago. The estimate of losses, placed at 6 per cent, is by far the most interesting item in the prospectus. As gates and sprues are not considered, it is evident that they are hidden away somewhere in the losses. On automobile cylinders, a 6 per cent shrinkage reflects a refinement of the art of founding not yet attained by those engaged in this line of work. The price at which the cylinders are to be sold does not reflect a profound familiarity with the motor car casting market—but why continue, as the awakening might prove the mine to have been salted.

Trade Outlook

Foundry trade conditions have shown little change during the past month, although it is the consensus of opinion in the iron trade that better conditions will prevail during the fall and winter seasons. Pig iron values, while low, are practically unchanged, although production has declined and stocks at some of the merchant furnaces have increased. A careful analysis of the foundry industry shows that requirements have principally been curtailed by automobile manufacturers, who, to a large extent, have cancelled contracts for both gray iron and brass castings. The railroad interests are not buying as freely as earlier in the year, but they continue to specify on existing contracts and the tonnage of both iron and steel castings that is being used by the railroads and car builders is enormous. While there has been a falling off in the consumption of malleable castings, founders specializing in this line of work are generally operating at about 80 per cent of their capacity, which can be considered normal at this season of the year. The shortage of skilled molders continues pronounced, notwithstanding the fact that many shops are operating with less than their normal quota of men. The effect of the increasing use of molding machines has not as yet made itself felt and it is evident, that notwithstanding the lull in the foundry business the tonnage of castings produced is almost as great as during any period in the history of the trade. No. 2 foundry iron, in the leading centers, is quoted as follows: Pittsburg, $15.15; Chicago, northern, $16.50; Cleveland, $15.35; New York, $15.75; New York, Virginia, $16.00; Philadelphia, $15.15; Birmingham, $11.50; malleable Bessemer, Chicago, $16.50; Lake Superior charcoal, Chicago, $18.50.

The American Sandless Casting Co. has been incorporated with a capital stock of $5,000,000 to acquire all patents relating to the process of casting iron in permanent metal molds granted to Edgar Allen Custer, Philadelphia. The incorporators are Frank M. Ritter, W. Northrope Cowles, Philadelphia, and S. D. Townsend Jr., Wilmington, N. J.

Personal

Wm. A. Beveridge has resigned as foundry foreman of the plant of the Bridgeport Deoxidized Bronze & Metal Co., Bridgeport, Conn.

H. R. Day, secretary and manager of the Union Malleable Iron Co., East Moline, Ill., has resigned to assume the management of the Oliver Mfg. Co., Chicago.

William G. Keller, formerly foreman of the foundry of the Ohio Foundry Co., Steubenville, O., has resigned to accept a similar position with the Western Foundry Co., Chicago.

Clinton A. Truesdale, formerly connected with the Southern Stove Works, Richmond, Va., has resigned to accept the position of superintendent of the Culter & Proctor Stove Co., Peoria, Ill.

J. C. Rock has resigned as foundry foreman of the Whitlock Coil Pipe Co., Hartford, Conn., and has returned to his former position as foreman of the brass foundry of the Bridgeport Deoxidized Bronze & Metal Co., Bridgeport, Conn.

Exhibition Company

AT a meeting of the executive committee of the Foundry & Manufacturers' Supply Association, held at the Hollenden Hotel, Cleveland, Monday, Aug. 8, the committee appointed to investigate the feasibility of incorporating this organization in accordance with the resolution passed at the annual meeting held in Detroit, presented the following report:

Since the convention in Detroit, we find that the molding machine manufacturers, and others, representing one-third of the space at the exhibit held in Detroit, have incorporated under the laws of the State of Pennsylvania as the Foundry & Machine Exhibition Co., with a capital of $25,000. After investigation, we find the purposes and intentions of this incorporation are identical with the objects of the organization which your association proposed.

Therefore, if after full and complete information concerning this corporation is submitted to the members, and if the same be found satisfactory to them, we recommend that the members of The Foundry & Manufacturers' Supply Association join the new corporation.

The committee selected to investigate the incorporation of this society, appointed by George R. Rayner, president-elect, consisted of S. T. Johnston, S. Obermayer Co., Chicago; Frederic B. Stevens, Detroit, and F. N. Perkins, Arcade Mfg. Co., Freeport, Ill. Secretary C. E. Hoyt was instructed to immediately advise the members of the association of the committee's report and a more complete statement will be issued by the executive committee in the near future. The report was presented by the committee to president-elect Rayner, by whom it was referred to the executive committee and was favorably acted upon.

Albert Spies

Albert Spies, owner and publisher of the *Foundry News*, New York City, died Tuesday, Aug. 16, at his home in Jersey City. Mr. Spies was born in New York 48 years ago and was graduated from Stevens Institute of Technology in 1881. For a number of years he edited *Cassier's Magazine*. He was a member of a number of technical societies, including the American Society of Mechanical Engineers. He is survived by his wife and a son.

Book Reviews

The Cupola Furnace, by Edward Kirk; 5½ x 9 inches, 106 illustrations. Furnished by THE FOUNDRY, carriage prepaid, for $3.50.

The third edition of The Cupola Furnace, recently issued, has been greatly improved by a rearrangement of chapters and a reclassification of subjects. Its scope and usefulness for the foundrymen have been extended by replacing the sections relating to foundry iron, foundry chemistry and other subjects, with chapters treating of modern practice. Other sections that do not directly pertain to cupola manipulation have been omitted. The new chapters, comprising about 200 pages, contain instructive, illustrated details of cupola accessories and cupola management. Scientifically designed cupolas and tuyere arrangements introduced in the past are also illustrated and described. This matter has been included to save the foundryman much experimental work when investigating cupola construction, and to eliminate the necessity of going over the same ground that has been exploited for years.

Laboratory Experiments in Metallurgy.—By Sauveur & Boylston, 8 x 10 inches, 75 pages, illustrated; supplied by THE FOUNDRY for $1.25.

This work describes experiments in metallurgy and is intended for the use of students and others, who are interested in the metallurgy of iron and steel. The experiments describe the coking and approximate analyses of coal; the Parr calorimeter, and how to ascertain the calorific power of charcoal, coal, etc.; the Siemen's water pyrometer; the Mesure and Nonel optical pyrometer, and the Le Chatelier thermo-electric pyrometer.

Experiments for the determination of the melting points of tin, lead and zinc are included as well as the reduction of oxides, and an explanation of the thermit reaction is given. The influence of carbon and nickel upon the tenacity, elasticity, and ductility of iron and steel is described, as well as the thermal critical points of steel, their relation to its hardening power and the effect of heat upon the grain. Tables of hardness factors for the Brinell ball test are given, with a description of the apparatus and mode of application. The book also contains much useful information in tabulated form, such as comparisons of thermo-metric scales, thermo-chemical data, etc.

Precis De Fonderie.—By L. Gorjon, 4½ x 7 inches, 330 pages, illustrated; published by the Libraire Technique, 15 Rue des Saintes-Peres, Paris, France.

This is a French work on foundry practice and is both interesting and instructive. The book is in two parts, and the first 49 pages are devoted to a discussion of the underlying principles of ramming and venting of molds, several instructive illustrations being given. Two chapters treat of the phenomena of liquation, of the influence of carbon, silicon, manganese, aluminum, titanium, and other metals and metalloids on cast iron, the cracking or rupture of castings due to imperfect design, and explains how to avoid these troubles.

The melting and mixing of irons are dealt with exhaustively and 26 types of cupolas are illustrated and described, some of which differ materially from those in use in American shops. Several chapters are devoted to malleable iron and steel, with illustrations of annealing ovens, converters, open-hearth furnaces and gas producers. The analyses of various steels as well as producer gases are also given.

The second part of the work, consisting of three chapters, takes up the subject of brass founding, beginning with a description of the various metals in use, being particularly rich in formulas for brass, bronze, white metals and babbitts. Numerous illustrations of crucible and reverberatory furnaces in use in Europe are included, and the work concludes with tables of melting points, formulas, and the analyses of various metals and alloys.

FOUNDRY and PATTERN SHOP EQUIPMENT

Dross skimming device---Metal melting furnace---Preparing core sand --- Jar-ramming, stripping-plate molding machine --- Foundry cranes --- Core molding machine

A NEW process of skimming and reclaiming metal drosses, devised by the Metal Dross Economy Co., Bristol, Conn., is shown in Figs. 1 and 2. The skimming tank consists of a cast iron box, 20 x 22 inches, and either 16 or 20 inches deep. It is covered with a steel top, in which there is an opening about 8 inches square, in the shape of a funnel. Over this opening is placed a shield at an angle of about 45 degrees, which is used to protect the caster from the heat, dirt and the smoke, which is so objectionable when skimming metal in the usual way. The tank is set in the floor so that the top will be about 4 or 5 inches below the top of the crucible when the skimming is done. The tank is raised above the floor so that the pot can rest against its side when standing alone. The tank is filled with water to a point about 2 inches below the top, the dross being skimmed directly into the water, as shown in Fig. 2, and in the same manner as that followed with the old-fashioned skimming heap. The skimming of dross into water eliminates the spelter smoke. As soon as the dross from the crucible strikes the water, the oxidation of metal ceases. By the old method, the brass continues to oxidize after it has been skimmed and lies on the skimming heap. The oxide of zinc immediately separates from the metal as soon as it touches the water, and takes the form of pellets of varying sizes.

At the end of the day the tank can be cleaned at any convenient time. The skimmings should not be permitted to dry, as the oxide of zinc will then adhere to particles of the brass and will be much harder to clean. The very fine shot metal is likewise more difficult to recover. If desired, the skimmings can be placed in a barrel, when wet, and cleaned later. By this process all of the charcoal that remains unburnt is saved for future use. At the left, Fig. 1, is shown the recovered charcoal from one day's work. It is claimed that 90 per cent more skimmings can be saved in this way than by the old method. To comply with the requirements of large and small foundries, the tanks are made in two sizes, the one holding skimmings from fifty No. 25 crucibles, and the other, the skimmings from sixty No. 70 crucibles. The water remains at about the same depth in the tank, regardless of the amount of dross, or charcoal skimmed into it, as the oxides and fine charcoal take up water in about the proportion in which they fill the tank.

After the skimmings have been removed from the tank, the oxides are cleaned from the metal in a dross separator, shown in Fig. 3, and at the right, Fig. 1. This separator is made of cypress wood and is provided with three drawers having wire cloth of different meshes over each drawer. A shovelful of dross is put in the top drawer and the particles are sifted according to size. Lumps of coal or sand balls containing brass in the top drawer are taken out and the sand balls are either put through a crusher, or are sold to the metal dealer. Anything remaining in the other drawers is used again in the foundry, either wet or dry. If used wet, it is advisable to place it in the crucible when the pot is charcoaled, putting it on top of the charcoal, or on top of chips, or in any other way to prevent the water from getting under the metal. The brass passing through the bottom cloth into the reservoir can be rewashed for the further recovery of the metal. The oxides may be saved if desired, although after passing through the second process there is little of value to be recovered.

FIG. 1—TANK INTO WHICH METAL DROSSES ARE SKIMMED. THE RECOVERED CHARCOAL FROM ONE DAY'S OPERATIONS IS SHOWN AT THE LEFT

Fuel Oil Furnace

A fuel oil furnace for metling nonferrous metals in crucibles, built by the Anthony Co., 45 West Thirty-fourth street, New York City, is shown in Figs. 1 and 2. The furnace consists of an outside steel shell, ¼ inch in thickness, lined with asbestos. Inside of this lining are rings of highly refractory fire brick of the proper thickness to make the combustion chamber conform to the size of the crucible used. The floor of the furnace is covered with fire brick, three openings being provided to carry off the metal, in the event of a broken crucible, into a vessel underneath the furnace. A circular block of refractory material is placed in the center of the floor of the furnace, on which

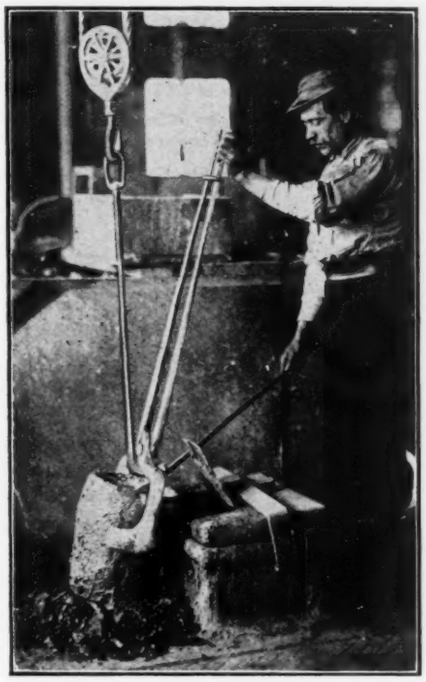


FIG. 2—SKIMMING DROSSES FROM A CRUCIBLE INTO THE TANK

the crucible stands, at a height that insures the greatest utilization of the heat.

The oil burner is so located that the oil enters a small combustion chamber, in which it is converted into gas. The gas then enters into the combustion chamber of the furnace and passes around the block holding the crucible, and thence upward until it encounters deflector rings, of such form as to direct the heat against the crucible uniformly throughout its entire circumference. These rings are set in position in such a way that if it is considered desirable to change from fuel oil to coal, or coke, at any time, they can be lifted out of the furnace, without disturbing the fire brick lining. The heat passes through the opening left between the deflector ring and the crucible, passing over the top of the pot to the stack. In this way the heat is confined within the lower half of the furnace and is directed against the lower part of the pot. This insures the proper melting of the metal with a soft reducing flame.

The oil burner used has been perfected after more than three years of continuous experimental work under service conditions. The burner atomizes the oil mechanically and delivers it as a fog, or mist, at a pressure of over 30 pounds. The oil enters the spraying plug through the oil inlets and enters a centrifugal chamber, where the oil is give a rapid, whirling motion. In passing from the burner to the combustion chamber, the oil is broken into minute particles, which permit the free admixture of air for combustion. The air is furnished by a fan blast, but free air, controlled by a damper, is also admitted through a round opening, where the burner is located, this being the only opening through which air can enter the combuston chamber, aside from that delivered by the fan. This method of air introduction gives the operator absolute control of both the oil and the air, and insures accurate regulation of both to meet any requirements.

The furnace is so constructed that the flame is in the nature of a gas flame and the oil does not impinge upon nor destroy the furnace walls. The crucible is so located in the furnace that all the heat is utilized and is directed where it is required. While the furnace is in operation, the hand can be slowly passed over the vent in the cover, as the temperature at this point is comparatively low, owing to the fact that the heat passes so slowly through the furnace that practically all of the waste heat is carried away by the flue.

The grate is so constructed as to permit a quick change from oil to coal, or vice versa. The middle grate bar may be removed, or the entire grate bars may be dropped on a hinge, if required. The cover is so made that by means of a cam it can be cleared from its seat and swung to one side with little effort. There is a bar hole

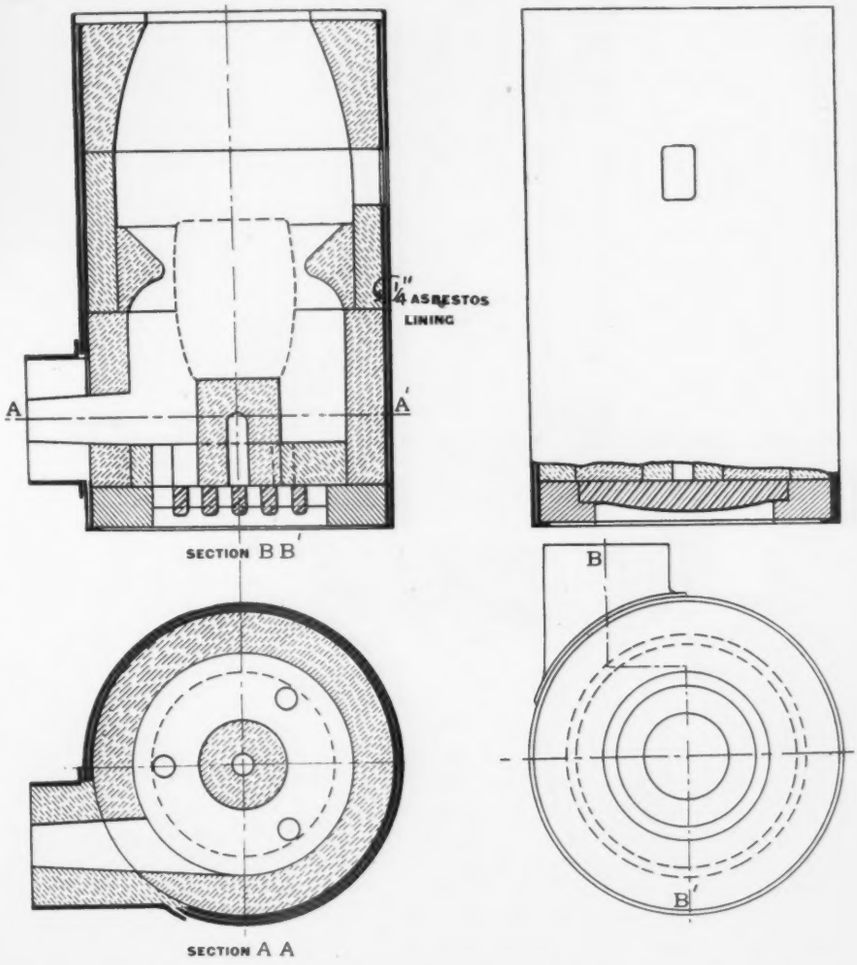


FIG. 1—PLAN AND SECTIONAL VIEWS OF THE ANTHONY CO.'S FUEL OIL, CRUCIBLE METAL MELTING FURNACE

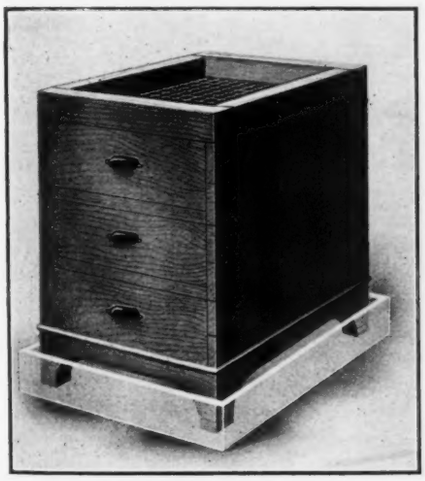


FIG. 3—DROSS SEPARATOR

in the cover for "feeling the metal." The shutter in front of the burner, Fig. 2, can be closed when the burner is not in use, thus retaining in the furnace, the heat which would otherwise be wasted through the circulation of cold air. The results of a run of four weeks with the first of these furnaces installed, follows: No. 70 crucible, 200 pounds to a charge; duration of run, 4 weeks; 5 melts per day; average time, 1 hour, 34 minutes; consumption of oil per heat, 4 gallons; average heats per pot, 27¾; air pressure, 3½ ounces; oil pressure, 45 pounds; temperature of oil, 160 degrees Fahr.; shrinkage in metal, 1.13 per cent highest, and 0.80 per cent lowest. At the end of this run the furnace was found to be in perfect condition, and greater economies could have been effected by increasing the number of heats per day, as the record shows that the consumption of but 3.10 gallons of oil on the last heat would have been maintained and probably reduced by one or two more heats. The maximum air pressure was only 3½ ounces, and for a considerable portion of the run it was reduced to less than 3 ounces. While the average life of the pot was 27¾ heats, the last crucible gave 39 heats, and two others gave 37 heats, each, which indicates that the working conditions of the furnace toward the end of the run had been improved.

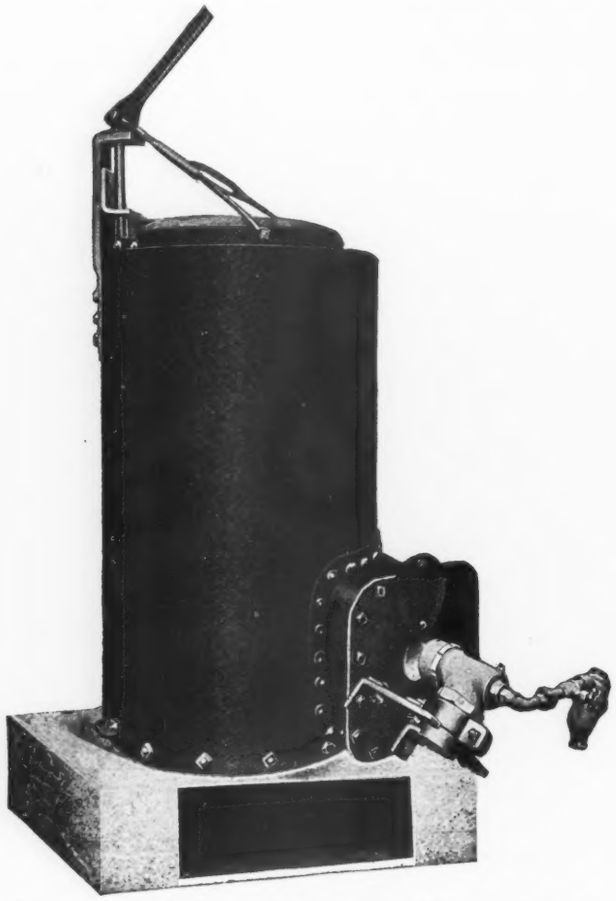


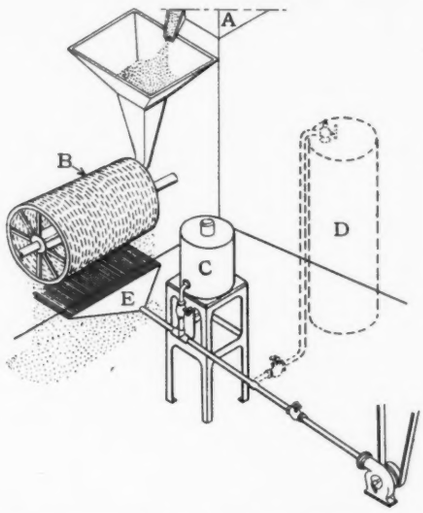
FIG. 2—THE ANTHONY CO.'S METAL MELTING FURNACE, SHOWING FUEL OIL BURNER

The Anthony Co. builds these furnaces in standard sizes best adapted to crucibles of various dimensions and capacities, and they are offered to the trade complete with burners and strainers. The strainers are made of special design, and absolutely prevent the clogging of the burner with foreign matter in the oil, and insures a uniform heat. This concern also furnishes the complete oil equipment, including not only the burner, strainer, fans and pumps, but oil storage tanks and all connections.

Preparing Core Sand

A new process of preparing core sand with a liquid binder has been developed by Jacob S. Robeson, of the Robeson Process Co., manufacturer of glutrin, Au Sable Forks, N. Y. Core sand mixtures, as generally prepared, lack uniformity and to effect a more intimate mixture of the liquid binding agent with the sand, the apparatus shown in the accompanying illustration is used. It will be noted that *A* is a sand drying chamber, fitted with a spout discharging into a hopper, from which it is delivered through a funnel-shaped spout to a rotary screen, *B*, which sifts the sand. This screen is so located that the liquid binder, in a finely divided state, may be discharged against and through the material as it leaves the screen. The tank containing the liquid binder is illustrated at *C*, and is provided with a pipe which delivers the binder to a discharge pipe connected with a blower. The discharge pipe has a flaring nozzle, *E*, through which the liquid binder, under the desired pressure, is discharged in a fine stream or atomized condition, in a substantially horizontal plane, against and through the falling sand as it is delivered by the screen. Instead of a blower, steam may be delivered to the discharge pipe from a steam boiler, *D*, which is indicated by dotted lines.

The spraying of the liquid binder in a finely divided condition, either under air or steam pressure, results in such an intimate admixture of the binder with the sand that a smaller amount of the binder is required than in ordinary practice, and in addition, better results are obtained. Every grain of sand receives a coating of the binder, and the mechanical bond produced by this treatment of the sand is greater than that produced by adding the binder in the old way, and the saving in the amount of binder required approximates 30 per cent. Furthermore, a greater quantity of old sand may be used with such a mixture. While compressed air is preferred as the means for separating the binder and for mixing it with the sand, it may be possible, under some conditions, to use the binder in a denser



PERSPECTIVE VIEW OF APPARATUS USED FOR PREPARING CORE SAND MIXTURES

state and to employ steam, under pressure, as the means of discharging it against the sand. This steam will carry such a content of water as will provide a given quantity of binder with an amount of moisture equal to that supplied in bulk, when compressed air is employed as the medium for discharging the binder against the sand. The difficulty, however, of determining this water content of the steam, and the danger of adding from such steam an excess of moisture which would seriously affect the adhesive quality of the binding agent, and consequently the character of the core, has led the inventor to prefer the use of compressed air. In most foundries both air and steam are accessible, and under the most favorable conditions, steam might be employed. The patent granted Mr. Robeson not only covers the process as relating to the preparation of material for the manufacture of cores, but also for the manufacture of briquettes from coal, or other fuel, iron or other ores, etc.

Jar-Ramming Machine

A new type of stripping plate molding machine, in which the ramming is accomplished by the jarring process, manufactured by the Herman Pneumatic Machine Co., Zelienope, Pa., is shown in the accompanying illustrations. Fig. 1 shows the pattern mounted on a pattern plate, which is fastened to the table plate of the machine. As shown in Fig. 2, the pattern plate projects upward in the center, thus forming a rest, upon which the pattern is placed. After the pattern is in position on this rest, the stripping plate is set down over the pattern onto the pattern plate. The flask is then placed in position on the stripping plate. Before throwing the sand into the flask however, it is usually desirable to provide a supplementary frame, about 4 inches high, and of the same dimensions as the flask, which is set over the top of the flask. By using this frame the additional sand placed within the same acts as a reserve to completely fill the flask, as the jarring proceeds. Most of this sand settles down into the flask, and upon the completion of the jarring operation, this frame is removed and the surplus sand is struck off. When the stripping plate and the flask are raised, in the position shown in Fig. 2, the flask is lifted off the stripping plate and is carried to the floor. By releasing the air from the side cylinders, the stripping plate is lowered to its former position, ready for the next mold.

The frame of this machine is rigidly constructed of cast iron, which rests on the foundation, and in this

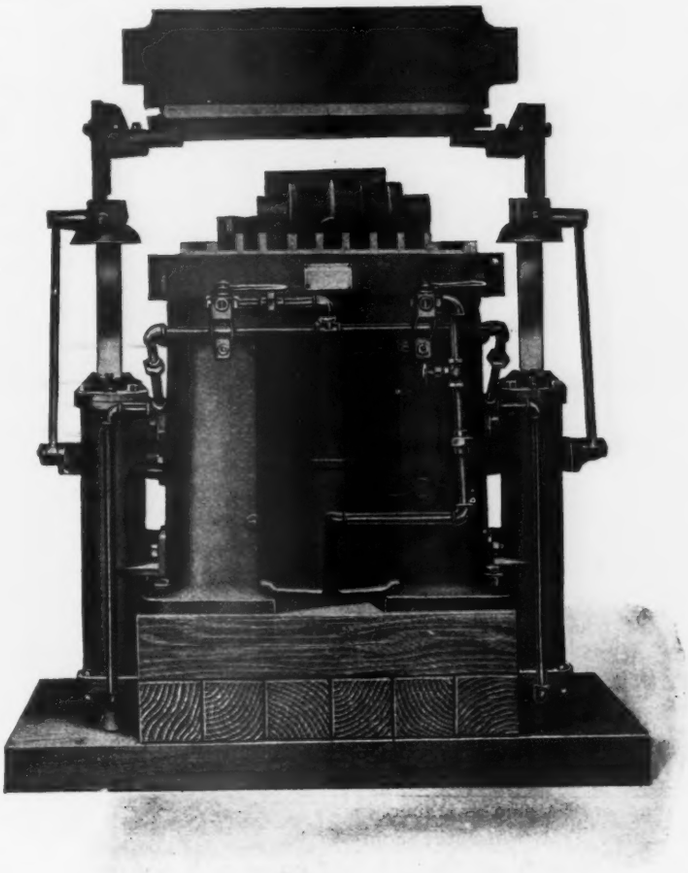


FIG. 2—FLASK AND STRIPPING PLATE, LIFTED FROM THE TABLE PLATE AND THE PATTERN SUPPORTED BY THE FORKS ON THE LIFTING SHAFTS

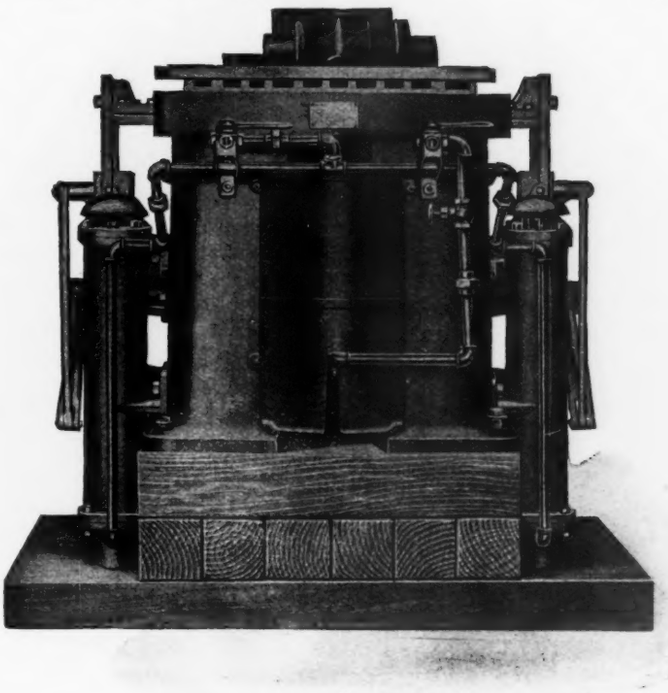


FIG. 1—JAR-RAMMING, STRIPPING PLATE MOLDING MACHINE, SHOWING THE PATTERN ON THE PATTERN PLATE BEFORE THE FLASK IS PLACED IN POSITION

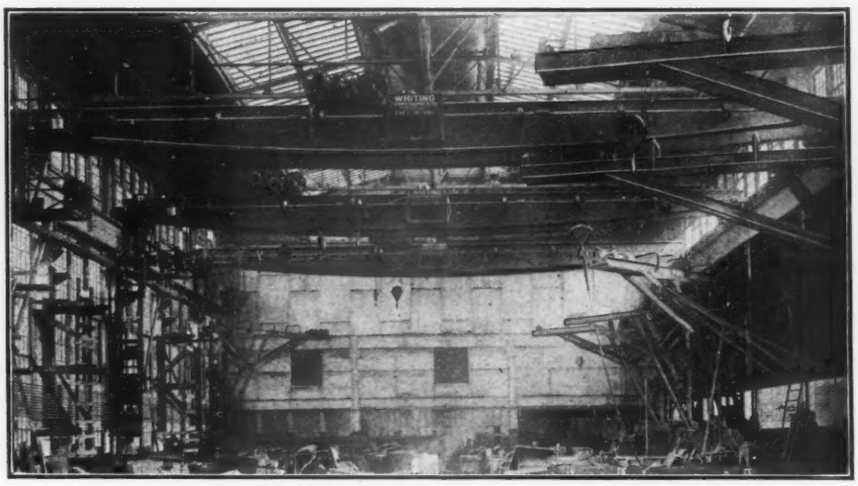


FIG. 1—VIEW OF THE MAIN BAY OF THE GENERAL ELECTRIC CO.'S FOUNDRY, SHOWING JIB AND TRAVELING CRANES

frame the movable plunger, which is attached to the table plate, is forced upward, released and allowed to fall back, by the action of compressed air controlled by an automatic valve. The table plate and plunger move upward and downward from 50 to 100 times per minute, according to the nature of the work that is being molded. At each side of the machine are cylinders which operate in unison, and their pistons are framed together in such a manner that when the compressed air is admitted to the cylinder, the two shafts, which are controlled by a main shaft at the back of the machine, move upward, lifting the flask and stripping plate from the table plate and pattern. The forks, which are attached to the lifting shafts, are adjusted to accommodate the various sizes of stripping plates and flasks. The draw can be arranged for any lift up to 20 inches. Stripping plates of other types of molding machines can be readily applied to this machine, which is built in eight sizes, with table plates from 24 x 30 inches to 60 x 72 inches in size.

Foundry Crane Installation

Considerable interest is attached to the crane equipment in the new foundry of the General Electric Co., Pittsfield, Mass. The apparently lavish outlay for cranes in this shop is explained by the class of work for which the plant was designed—the production of cast iron transformer shells. These shells, and the molds in which they are cast, are at once heavy and awkward, and considerable economy is realized by the extensive crane equipment. All the cranes were furnished by the Whiting Foundry Equipment Co., Harvey, Ill.

Fig. 1 shows three of the traveling cranes and several of the steel jib cranes in the main bay of the foundry. A more detailed view of the jib cranes is shown in Fig. 2. In the main foundry are three 10-ton traveling cranes, each 70-foot span, fitted with standard Whiting equipment, including main and auxiliary hoists. There are also one 5-ton and one 20-ton crane in the main foundry.

The jib cranes have a capacity of four tons each. They are electrically operated and floor-controlled. The jib cranes are carried on the regular building columns, which are made heavy for the purpose. The motors and hoisting mechanism on these cranes are located on the vertical struts, comparatively close to the ground, making them easy of access for inspection and repairs. These jib cranes are particularly valuable in handling copes, etc., on the floor, and are a material factor in increasing the output of the shop. In fact, the entire crane equipment of this plant is an excellent example of the present tendency to use jib cranes for detail work on the floor, leaving the traveling cranes free to handle heavy weights and for transportation purposes.

In addition to the crane equipment enumerated above, this foundry is fitted with one three-ton traveling crane of 48-foot span in the core room. This crane is particularly useful in handling the heavy transformer cores. In the cleaning room in the sub-cellar are five two-ton and nine one-ton cranes.

Considerable cleaning room equipment was installed on account of the large production of small transformer parts. The equipment includes two 30 x 42-inch, four 36 x 60-inch round, and two 42 x 72-inch square Whiting tumblers, each fitted with individual electric motors. This department is also equipped with four motor-driven grinders, one Whiting sand blast machine and an efficient dust collector system.

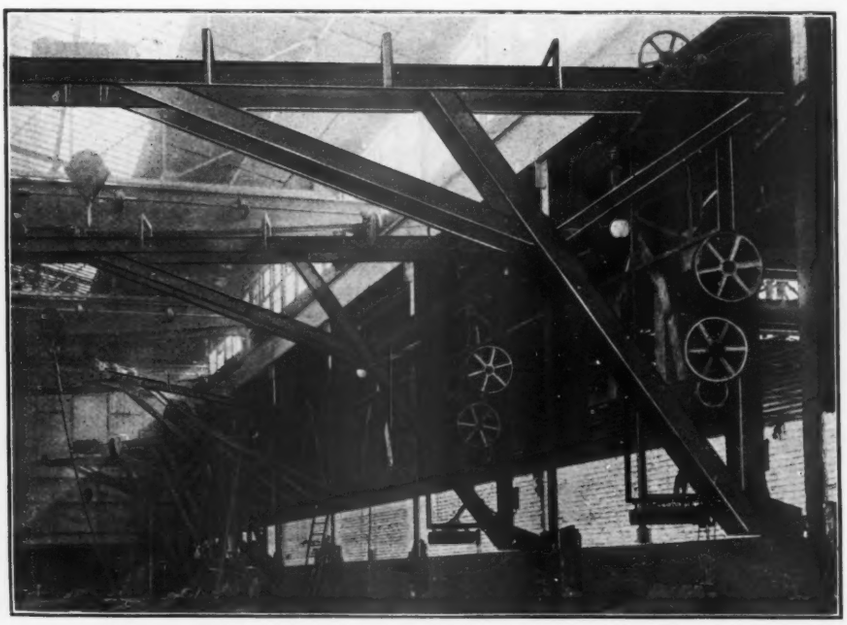


FIG. 2—MOTOR-OPERATED JIB CRANES IN THE GENERAL ELECTRIC CO.'S FOUNDRY

Crucible Steel Mixtures

Boiler punchings are very easy to pack into crucibles, and for that reason are preferred as melting stock in making crucible steel castings. Their composition should approximate:

	Per cent.
Carbon	0.15
Manganese	0.26
Phosphorus	0.5
Sulphur	0.4

The crucible should be charged before being placed in the furnace, and a cover, which may consist of a bot-

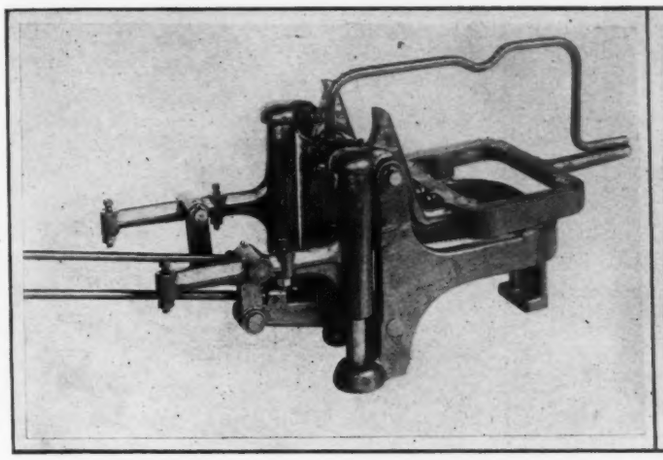


FIG. 1—ROCK-OVER CORE MOLDING MACHINE

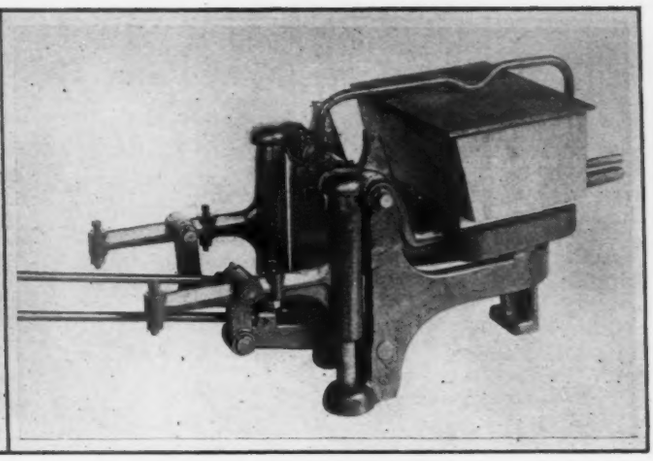


FIG. 2—CORE RAMMED AND DRIER PLATE IN POSITION

tom of an old crucible, is luted on to protect the metal as much as possible from the injurious effects of the flame. The cover should be pierced with a 2-inch hole through which the progress of the heat may be observed and the final additions made. This hole is in turn covered with a piece of fire brick, which is easily pushed aside and replaced as occasion requires. A deep cover, such as the bottom from an old crucible, cut high up, possesses some advantages, as it permits a greater quantity of cold metal to be charged than a flat one, inasmuch as after the cover is mudded on, the punchings can be filled in, through the hole. In using a new pot it is advisable to get it as full as possible, as subsequent charges are generally reduced, so that no two will have the same slag line. Therefore, if the pot is well filled at the first melt, it is possible to obtain the maximum output of melted metal from each crucible.

A charge of all punchings may consist of boiler punchings 100 pounds. When a thin wrought iron bar inserted through the peep hole comes out coated with slag only, the metal is sufficiently hot for the additions, which are as follows:

80 per cent ferro-manganese	1 pound
50 per cent ferro-silicon	1 pound
Pure aluminum	½ ounce

The additions must be broken into small pieces, about the size of a hazel nut, and are added to the steel in the crucible, by means of a section of 2-inch gas pipe, which is passed through the hole in the cover of the furnace, to the hole in the crucible cover, and the manganese and silicon are allowed to slide down the pipe. Charcoal is sometimes used to increase the carbon in the steel, and 1 ounce of charcoal is generally figured as adding 0.04 per cent of carbon, and in a new crucible add 0.1 per cent of carbon. This has to be taken into consideration when figuring out the mixtures.

The following alloy is harder than the one just given, and shows a dense white fracture: Charge punchings, 96 pounds; charcoal, 8 ounces; when melted add (50 per cent) ferro silicon, 10 ounces; and pure aluminum, 1 ounce.

An ordinary grade of tool steel can be made from the following mixture:

Tool scrap	25 pounds
Bar iron	45 pounds
Punchings	20 pounds
Washed metal	10 pounds
Charcoal	5 ounces
Melt, and add:	
Ferro-chrome	3 ounces
Ferro-manganese	4 ounces
Aluminum	½ ounce

Core Machine

A rock-over core molding machine, manufactured by Henry E. Pridmore, Chicago, is shown in the accompanying illustrations. In Fig. 1 is shown the machine without the drier plate or core box in position. In Fig. 2 the core box has been set on the table, the core rammed with the plate in position, and the clamping rod adjusted, ready for rocking over the core. In Fig. 3 the core has been rocked over and the plate is in position on the equalizing pins. Fig. 4 shows the clamping rod lowered, and the core dropped away from the core box. In Fig. 5 the core box has been rocked back and the core is shown on the drier plate ready to be carried away. The core box is in position for making the next core. Fig. 6 shows the

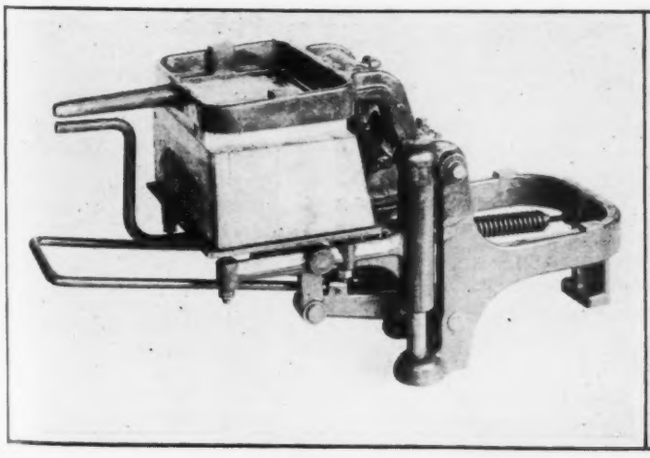


FIG. 3—THE CORE ROCKED-OVER

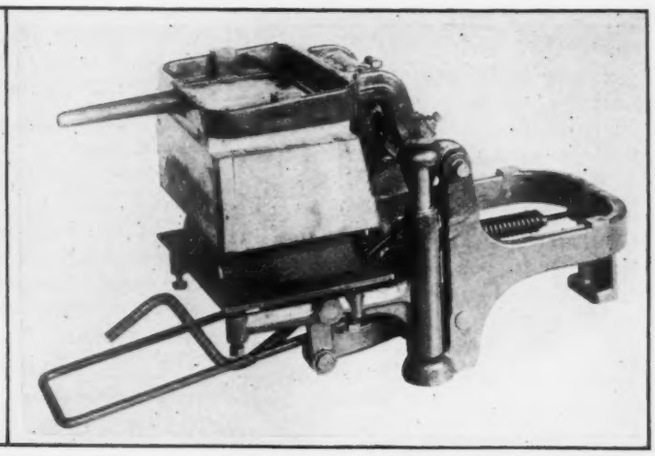


FIG. 4—CORE ON THE DRIER PLATE LOWERED AWAY FROM THE CORE BOX

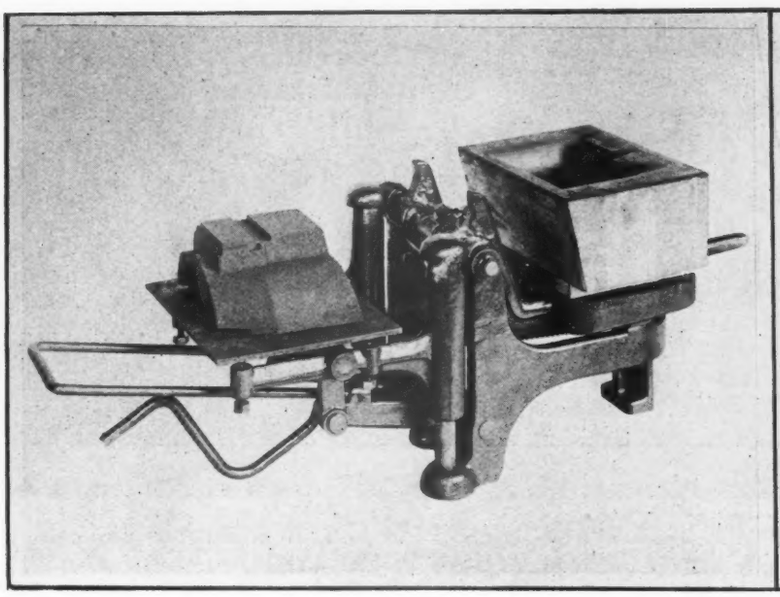


FIG. 5—CORE FINISHED, READY TO BE CARRIED AWAY. THE CORE BOX IS IN POSITION FOR MAKING ANOTHER CORE

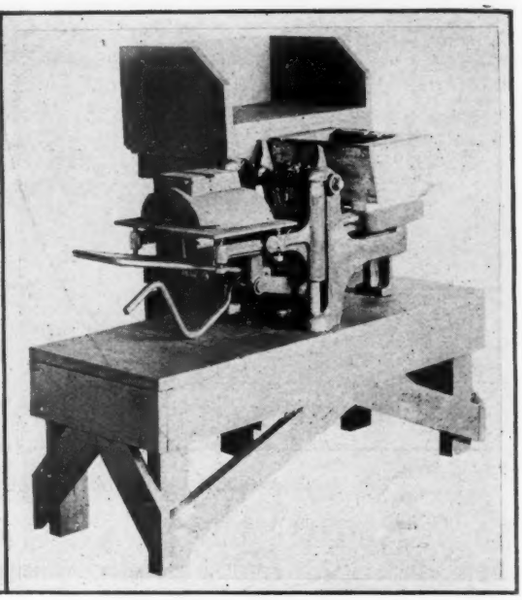


FIG. 6—ROCK-OVER CORE MOLDING MACHINE ON CORE BENCH

machine in position on a core bench, as installed in a core shop. The entire machine is a small model of the Pridmore rock-over molding machine, and the operating mechanism is similar in every way to that of the larger molding devices. Its use effects great economies in the production of cores, as the output is materially increased and the cores are truer to pattern than when made by hand on the bench.

Briquetting Cast Iron Borings

The use of cast iron borings in the cupola has always involved great difficulty, in view of the fact, that the heats rarely ever show that any of the material so charged has been recovered. This either indicates that the borings have been blown out of the cupola by the blast, or that they have been oxidized and carried away with the slag. Various methods of charging the borings have been tried but it seems that briquetting this material gives the most satisfactory results. A mold for these briquettes made from ordinary lumber, tapering from 13 x 7 inches at the top, to 12 x 6 inches at the bottom, will form briquettes weighing from 50 to 55 pounds each. A tapered mold is preferred, as the briquettes can more easily be removed from the boxes. The material is mixed with a briquetting compound, or binder, manufactured by the S. Obermayer Co., Cincinnati, which is thoroughly mixed in a dry state and sufficient water is added to temper the mixture, in practically the same way that an ordinary core mixture is prepared. The borings mixed with the compound are then compressed in the mold, by the use of either compressed air, or a hand press, and a jarr-ramming or squeezer molding machine can likewise be used for this work. Approximately 50 pounds of the briquetting compound are used per ton of borings. Briquettes, before using, should be permitted to remain in a temperature ranging from 75 to 80 degrees Fahr. for a period of 48 hours, when they are ready for use. When charging the briquettes they should not be placed on the coke bed, but should be included in the subsequent charges. The borings should be charged on top of the scrap before the coke is added. Approximately 10 to 15 per cent of borings may be used to each cupola charge.

Trade Notes

The Piqua Blower Co., Piqua, O., is installing a motor-driven cupola blower in the plant of the Walworth River Foundry Co., Cleveland.

The Ingersoll-Rand Co., New York City, has published a 24-page circular illustrating and describing coal punchers used in coal mining operations.

The Kansas City warehouse of the J. D. Smith Foundry Supply Co., Cleveland, has been removed from 423 West Sixth street to 2020 Baltimore avenue.

W. S. Rockwell Co., 50 Church street, New York City, is sending a circular to the trade describing its spring fitting furnaces, using oil or gas for fuel. These furnaces are intended for heating springs.

The Adams Co., Dubuque, Ia., manufacturer of molding machines, is sending to the trade a folder entitled "A Safe Line to Choose From," which contains illustrations of 28 styles of Farwell molding machines.

The Philadelphia offices of Stanley G. Flagg & Co. will be removed to the Morris building, Chestnut street, west of Broad street, about Sept. 15. The executive staff and sales departments will be located in these headquarters.

Owing to the increased pressure of work at its New York and Philadelphia offices, the Stoughton Engineering Co., 165 Broadway, Nen York City, foundry engineer and manufacturer of the "Seco" converter has discontinued its Pittsburg office.

The W. S. Rockwell Co., 30 Church street, New York City, is building two double end annealing muffles for the Bristol Brass Co., Bristol, Conn., and is also installing annealing and hardening furnaces for the New Departure Mfg. Co., of Bristol. Other orders include two annealing furnaces for the International Silver Co., Meriden, Conn., and Landers, Frary & Clark Co., New Britain, Conn. An annealing furnace is also being installed by this concern in the plant of the International Silver Co., Wallingford, Conn.

Trade Publications

FOUNDRY EQUIPMENT.—Walter Macleod & Co., Cincinnati, have issued a catalog describing their line of foundry equipment, torches for lighting cupolas, heating ladles, skin drying molds, etc.; in addition, a sand blast is described, as well as brazing and welding outfits using the oil or oxy-acetylene process.

FLASKS AND SLIP JACKETS. — The Linn Mfg. Co., Springfield, O., in a four-page circular, illustrates and describes its line of steel-coated taper flasks and steel jackets. These flasks are made both square and circular and are steel lined, making them absolutely moisture proof. Galvanized steel slip jackets with wood handles, as well as cast iron slip jackets, are also shown.

CHAIN BLOCKS AND ELECTRIC HOISTS.—The Yale & Towne Mfg. Co., New York City, in a 28-page booklet, briefly illustrates and describes its line of chain blocks and electric hoists. Blocks of various types are shown, including triplex blocks, spur geared blocks, duplex blocks, differential blocks, electric hoists, motor-driven trolleys, geared trolleys, safety crabs, trolley tracks, single I-beam travelers, etc. A price list is also included.

ORE AND COAL HANDLING MACHINERY.—The Brown Hoisting Machinery Co., Cleveland, has published a handsomely illustrated catalog, showing recent installations of some of its machinery. In the preparation of this work no effort was made to give a detailed description of the machinery, its operation and the amount of material each unit handles, but this information will be gladly given by the manufacturer to those who are interested. The illustrations show installations of ore bridges, blast furnace hoists, cableways, coal-handling plants, pig iron breakers, ore and coke bins for blast furnaces, cranes, transfer cars, etc. Typographically the catalog is a work of art.

GENERAL INDUSTRIAL NOTES

The Wileg Foundry & Machine Shop will be removed from Temple to San Angelo, Tex.

The American Sheet & Tin Plate Co., Canton, O., is building a large addition to its foundry.

The Temple Machine & Foundry Co., Temple, Tex., will remove its plant to Cleborne, Tex.

The Belle City Steel Casting Co., Racine, Wis., has increased its capital stock from $4,000 to $10,000.

The Central Steel Co., Ottawa, Ill., has been incorporated with $10,000 capital to engage in the manufacture of steel castings.

The United States Rediator Co., Dunkirk, N. Y., has taken over the works of the Central Radiator & Foundry Co., Paola, Kans.

The Imperial Iron & Foundry Co., Delmar Heights, Oklahoma City, Okla., has been incorporated with $50,000 capital; M. C. Clark is president.

The Withers Foundry & Machine Co., Atlanta, Ga., has been incorporated with a capital of $80,000, by Walter G. Withers, W. T. Withers and J. B. Withers.

The Best Foundry Co., New Kensington, Pa., has been incorporated with a capital of $15,000 to engage in the manufacture of gray iron castings. C. M. Best is treasurer.

The Farrell-Cheek Foundry & Machine Co., Sandusky, O., is erecting a foundry building of steel and brick construction, 100 x 100 feet, and is installing a converter for the production of steel castings.

The Frank Way Foundry & Machine Co., Chillicothe, Mo., manufacturer of gray iron and brass castings, has been succeeded by the Chillicothe Foundry & Machine Co. F. B. Wheeler is president and general manager.

The Aetna Foundry & Machine Co., Warren, O., is enlarging its foundry and will later install a new cupola. The machine shop is also being extended, and a new three-story brick building has been built for use as a pattern shop.

The Grafton Mfg. Co., Martins Ferry, O., has been incorporated with a capital of $15,000 to engage in the manufacture of babbitt metal, etc. The incorporators are: W. S. Grafton, F. H. Grafton, P. Dougherty, I. F. Bates and M. McDermott.

The Rockford Sprinkler Co., Worcester, Mass., has purchased the property recently occupied by the James H. Whittle Co. The Whittle plant includes a foundry, 60 x 80 feet, and a pattern shop, 18 x 190 feet. A large amount of new equipment will be purchased.

The firm name of F. S. Wakefield Bros. Co., Vermilion, O., has been changed to the Wakefield Brass Co., and this concern has been incorporated with a capital of $10,000 by Fred W. Wakefield, Albert C. Hopicker, Ernest H. Wakefield, Arthur J. Copeland and W. T. Danmore.

The Hyde Park Steel Casting Co., Hyde Park, Mass., recently incorporated with a capital of $25,000, has taken over the plant of the New England Steel Casting Co. The officers of the Hyde Park Steel Casting Co. are as follows: Simon J. Coleman, president and W. M. Murray, treasurer.

The foundry business conducted since 1867 by Charles Brunner at Peru, Ill., has been incorporated under the name of the Brunner Foundry & Machine Co. The officers of this concern are as follows: Charles Brunner, president; H. B. Nadler, secretary and treasurer; G. A. Weller, general manager.

The Crucible Steel Castings Co., Cleveland, which erected a plant some months ago at 1800 Canal road, has been incorporated with a capital of $25,000. The officers are as follows: Wm. Schmehl, president; Charles Kaufman, vice president; A. H. Kaufman, secretary and treasurer, and H. L. Aiken, general manager.

The plant of the Hubbard Steel Foundry, East Chicago, Ill., has been placed in operation. The expenditure for improvements is estimated at $100,000, and further extensions are outlined for the future. This concern will engage in the manufacture of castings for rolling mill equipment. Steel is melted in a 25-ton open-hearth furnace.

The Wisconsin Foundry & Machine Co., Madison, Wis., recently incorporated with a capital stock of $60,000, has taken over the plant and business of the King & Walker Co., manufacturer of cylinder presses. It is the intention of this concern to continue the manufacture of these presses and to conduct a general foundry and machine shop business. A new shop will be erected, 60 x 132 feet.

The Power Specialty Co., New York, has just completed the erection of a foundry, 100 x 140 feet, at its works in Dansville, N. Y. The building is of steel, brick and concrete, and will be equipped with electric traveling cranes, industrial railway, core ovens, core machinery and a complete equipment of molding machines suitable to the requirements of the special line of work made in this shop.

Operations have been commenced in the extension to the plant of the Walworth Run Foundry Co., Cleveland. This addition practically doubles the capacity of this shop. The new buildings consist of a concrete and steel foundry, 154 x 270 feet; cleaning department, 105 x 50 feet, and several smaller structures. All of the equipment is operated by individual motors, nineteen having been installed, ranging in capacity from 5 to 75 horsepower. The current is purchased from the Cleveland Electric Illuminating Co. The cupola in this new addition is 90 inches in diameter, and was installed by the Whiting Foundry Equipment Co., Harvey, Ill. The blast is provided by a blower furnished by the Piqua Blower Co., Piqua, O. A contract for a large number of molding machines has been awarded to the Arcade Mfg. Co., Freeport, Ill., but additional machines will be installed in the near future.

New Construction

C. J. Moberg will build a die-casting foundry at Mt. Vernon, N. Y.

The Parker Foundry Co., St. Lambert, Que., will erect a foundry.

C. T. Shaw, Natchez, Miss., will enlarge and improve his iron foundry.

The Temple Iron Works, Temple, Tex., will

The Standard Foundry Co., Detroit, is building an addition to its foundry.

erect a foundry at San Angelo, Tex.

The Pittsburg Foundry Co., Los Angeles, Cal., is erecting a new foundry, 40 x 70 feet.

The Badger Foundry & Machine Co., Sheboygan, Wis., is erecting a steel and brick foundry.

The Sharon Foundry Co., Sharon, Pa., will erect an addition to its pattern storage house, 50 x 60 feet.

The Deemer Steel Casting Co., New Castle, Del., will erect an addition for use as a cleaning department.

The Sharon Foundry Co., Wheatland, Pa., is enlarging its plant by the addition of a pattern shop, 60 x 65 feet.

The Nute Foundry Co., Cuyahoga Falls, O., is enlarging its plant by the erection of a brick building, 20 x 90 feet.

The Fort Dodge Iron & Metal Co., Fort Dodge, Ia., owned by Robinson Bros., contemplate the erection of a foundry.

The Manufacturers' Foundry Co., Waterbury, Conn., is erecting an addition, 54 x 68 feet, to be used as a finishing room.

The Smalley Mfg. Co., Manitowoc, Wis., will erect a three-story building 80 x 100 feet, which will include a foundry and machine shop.

The Ohio Pattern Works, Cincinnati, proposes to increase its capital and is now having plans prepared for a one story concrete building, 83 x 100 feet.

The Smalley Mfg. Co., Manitowoc, Wis., is preparing plans for the erection of a three-story factory building, combining a foundry, machine shop, and planing mill.

F. E. Meyers & Bro., Massillon, O., contemplate extensive improvements, which will include a foundry, 140 x 25 feet, for the production of gray iron castings.

The Grant Bros. Foundry Co., Detroit, is now erecting an addition to its plant, 30 x

70 feet, which will be used for core room, cleaning and shipping department.

The Atlas Foundry & Machine Co., Tacoma, Wash., will erect a concrete and brick foundry building, 100 x 100 feet, at Bailey and Thirty-first streets, at a cost of $10,000.

The Christie Engine Co., Waterloo, Ia., has purchased a tract of about 31 acres in North Waterloo, which will be used by the company for a factory site. The new plant will include a foundry.

The American Valve & Metal Co., Cincinnati, O., has commenced work on the erection of a new plant on Spring Grove avenue, the main building of which will be, 62 x 173 feet, with an ell, 62 x 82 feet, two stories high.

The Aluminum Co. of America, New Kensington, Pa., has awarded contracts for the erection of two buildings, each 40 x 116 feet, one to be used as a molding room and the other as a warehouse.

The Norton Car & Foundry Co., Norton, Va., has increased its capital stock from $15,000 to $40,000 and proposes to build a foundry and machine shop for doing general repair work on mining cars.

The Jewel Steel & Malleable Co., Buffalo, N. Y., is having plans prepared for a new brick and structural steel foundry building, 140 x 160 feet. John H. Coxhead, 928 Ellicott Square, is the architect.

The city of Milwaukee will establish a municipal repair shop, consisting of a foundry, forge, machine and carpenter shop. This will be used for repairs and also for building much of the apparatus which it uses.

The Hooven, Owens & Rentschler Co., Hamilton, O., will add two stories to its pattern shop, and is also erecting a new building, 69 x 116 feet, four stories high, of reinforced concrete construction. A pattern storage warehouse, 50 x 82 feet, is also being built.

The Iowa Malleable Iron Co., Fairfield, Ia., has let contracts for the construction of an addition to its foundry, 106 x 140 feet, and an addition to its annealing room, 80 x 130 feet. Both buildings will be of steel frame construction. This concern is also erecting a large addition to its core room.

The Thompson-White Mfg. Co., Portland, Ore., has been incorporated with a capital of $250,000 and will build a foundry and machine shop, for the purpose of manufacturing valves. The plant will consist of two buildings, one 50 x 100 feet, two stories, and the other 50 x 100 feet, one story.

The Railway Brake & Shoe Co., Moundsville, W. Va., contemplates the erection of a plant for the manufacture of brake shoes for car wheels. The brake shoes are made of a malleable iron. The company plans to erect an 80 x 300-ft. building to cost $10,000 and to install upwards of $20,000 worth of equipment.

The Pontiac Foundry Co., Pontiac, Mich., recently organized with a capital of $80,000, has broken ground for the erection of a gray iron and brass, jobbing foundry. The main building will be 270 x 170 feet, with an ell, 32 x 60 feet. The officers of the company are as follows: R. A. Palmer, president; J. D. Brennan, vice president and superintendent; R. E. Baus, treasurer, and E. H. Halsey, secretary.

The Central Sash Weight & Foundry Co., Oklahoma City, Okla., has been incorporated by Max K. Weigel, and others, with a capital of $25,000, to engage in the manufacture of sash weights. A new plant will be erected and a part of the equipment of the Southwestern Iron Works, Wellington, Kans., will be used in the new shop. One cupola will be operated for melting metal for sash weights, while another cupola will be installed for gray iron castings. This concern is in the market for a crane, a small air compressor, and several molding machines.

The Cockshutt Plow Co., Brantford, Ont., will expend from $300,000 to $400,000 in the erection of additions to its plant this year. This will consist of a six-story warehouse, 150 x 60 feet; four-story experimental building, 65 x 64 feet; three-story pattern storage building, 50 x 40 feet; three-story machine and erecting shop, 106 x 60 feet; three-story casting storage and paint shop, 105 x 60 feet; foundry building, 215 x 70 feet; structural shop, 192 x 50 feet; blacksmith shop, 154 x 70 feet; iron storage building, 128 x 100 feet; shearing shop, 100 x 32 feet, and a cupola house, 52 x 32 feet. These additions will double the capacity of the plant.

The Treadwell Engineering Co., Easton, Pa., a consolidation of M. H. Treadwell & Co., Lebanon, Pa., Lebanon Steel Casting Co., Lebanon, Pa., and the Stoever Foundry & Mfg. Co., Myerstown, Pa., has been incorporated with a capital of $400,000. A new plant will be erected at Easton, which will combine the three works. In addition to three machine shops, each 100 x 250 feet, a forge shop, 100 x 250 feet, erecting shop, 100 x 600 feet, a gray iron foundry, 150 x 350 feet, and a steel foundry, 140 x 250 feet, will be erected. The gray iron shop will have sufficient melting capacity to pour castings up to 50 tons in weight. In the steel foundry, castings will be made by the crucible process. A pattern storage building will be built, 50 x 100 feet, two stories high.

The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has purchased a tract of 70 acres at Trafford City, Pa., adjoining the large foundry of the Westinghouse Machine Co. A gray iron and steel foundry will be erected on this site, which will be one of the largest of its kind in the world. As soon as this plant is completed it is probable that the Cleveland foundry, as well as the one located on the North Side, Pittsburg, will be dismantled. At the present time castings used for East Pittsburg are shipped from Cleveland and from the Pittsburg plants. The Trafford City works of the Westinghouse Machine Co. and the East Pittsburg plants are connected by the Inter-works Railway, which affords excellent shipping facilities between the various plants of the Westinghouse interests.

The Lima Locomotive & Machine Co., Lima, O., is erecting a foundry, 380 x 120 feet, of brick and steel construction. The center span is 60 feet wide, 36 feet high to the center roof trusses, and 28 feet to the top of the crane rail, on which will operate a 15-ton electric traveler. The wings on either side of the building will be 30 feet wide, extending the full length of the shop. The height under the roof trusses will be 18 feet. The entire north wing of the foundry will be occupied by the cleaning department, flask carpenter's room, brass foundry, core room, and for the cupolas and charging floor; 100 feet of the center span and south wing will be used as a casting storage room and will be partitioned off by a fire wall from the cleaning department. A standard gage track will extend through the building at right angles between the casting storage room and the molding floor. Folding doors will cover the openings in both sides of the building. The remainder of the center span and south wing will be used for molding purposes. The south wing of the molding floor will be equipped with a 3-ton electric crane, as well as the core room and the cleaning room in the north wing. The melting equipment will consist of two cupolas, 72 and 42 inches inside diameter, respectively. The material will be carried to the charging floor by two electric elevators and the blower room will be located underneath the charging floor. The charges will be made up in the yard, directly opposite and convenient to the elevators. All raw material will be stored so that it can be conveniently handled by an industrial railway system, which will serve the entire foundry for the transfer of raw and finished material. The charges will be weighed on scales located in the yard. The cleaning room will be equipped with a battery of exhaust tumbling mills and such other equipment as may be required. The wash room and locker room will be in the north wing, directly over the brass foundry.

Among the Brass Foundries.

The Ryder Brass Foundry, Bucyrus, O., has placed its machine shop in operation.

A. H. Caplan & Co., Ottawa, Can., are erecting a building for the manufacture of babbitt metals and solder, and will also install a smelting and refining plant.

The new plant of the Kroenert Smelting & Refining Co., 6620 Kelly street, Pittsburg, Pa., is now in operation. Two furnaces have been provided for smelting and refining metals. The shop is 50 x 75 feet.

The firm name of the Hotz Foundry Co., Fremont, O., has been changed to the Hotz Foundry Mfg. Co. A building, 50 x 150 feet, two stories high, will be erected. This concern manufactures brass, bronze and aluminum castings.

The plant of the Thomas Brass & Iron Co., Waukegan, Ill., recently destroyed by fire, will probably be rebuilt. While no definite statement has been made as to the future policy of this concern, the rebuilding of the plant is beeing considered by the stockholders.

Brass rolling mills throughout the Naugatuck valley in Connecticut, are operating at capacity, although the brass foundries are not as busily engaged as during the spring months. The plant of the New Departure Mfg. Co., Bristol, Conn., is operating night and day on coaster brakes and ball bearings.

The Ryder Brass Foundry has been established at Bucyrus, O., by P. H. Ryder. A specialty will be made of brass, bronze and aluminum castings. The shop is of brick construction and in addition to the molding floor contains a core room, pattern storage and finishing department. Twelve molders are employed at present.

The Bayonne Casting Co., Bayonne, N. J., has received a large contract for Monel metal castings, which is said to be the largest order of this kind ever placed. The contract provides for twelve propellers for the large battleships now being built for the Argentine Republic, in the yards of the Fore River Shipbuilding Co. and the New York Shipbuilding Co. These wheels will be furnished in Monel metal in one piece, each about 15 feet, 6 inches in diameter and weigh approximately 16,000 pounds. A contract for four Monel metal propellers for the U. S. S. Florida, recently launched at the Brooklyn Navy Yard has also been received. These propellers will be 10 feet, 6 inches in diameter and will weigh about 8,000 pounds each. The plant of the Bayonne Casting Co. has recently been completed at a cost of approximately $75,000. The furnace capacity is sufficient to melt 40,000 pounds of Monel metal daily. The shop is equipped with a 20-ton crane, provided with a 5-ton auxiliary, as well as two 7½-ton jib cranes. W. J. Edwards is president and LeRoy Edwards is treasurer of this concern.

Whiting Electric Traveling Cranes

AND CRANES OF ALL TYPES FOR ALL PURPOSES

Special Electric Traveling Crane, 5 tons capacity. Complete equipment for Pipe Foundry, including Cupolas, Core Ovens, Flasks, Patterns, etc., furnished Delaware, Lackawanna & Western R. R., Scranton, Pa.

Complete Equipment for Foundries

FOR ALL CLASSES OF CASTINGS:

Grey Iron, Brass, Car Wheel, Pipe, Steel and Malleable

Layouts Furnished - Equipment Installed

Plants Turned Over to Owner Ready to Operate

MANUFACTURERS
ENGINEERS
AND
DESIGNERS

WHITING FOUNDRY EQUIPMENT CO.

HARVEY, ILL. (Chicago Suburb)

SEND FOR CATALOGS SEE OTHER ADV. PAGE 52

ADVERTISERS

Adams Co. 22
Addy, Matthew, & Co..... 150
Ajax Metal Co..... 145
American Air Compressor Works..... 132
American Blower Co..... 126
American Compressor & Pump Co..... 129
American Vanadium Co..... 43
Anthony Co. 42
Arcade Mfg. Co..... 21
Ardelt & Sons..... 137
Atlas Car & Mfg. Co..... 116

Baird & West..... 150
Baldwin, Tuthill & Bolton..... 131
Barnett, Oscar, Foundry Co..... 133
Barry & Zecher Co..... 140
Bartley, Jonathan, Crucible Co..... 50
Bayliss Chemical Laboratory..... 149
Berkshire Mfg. Co.....18, 19
Betton, J. M..... 121
Birkenstein & Sons, S..... 146
Blackwell, Geo. G., Sons & Co., Ltd..... 146
*Blake, Geo. F., Mfg. Co..... 140
Brass Founders' Supply Co..... 131
Breen, Wm. J., Co..... 150
*Bretaud, J. V. 122
Brown Hoisting Machinery Co. 107
Brown Specialty Machinery Co..... 10
Buch's Sons Co., A..... 24
Burdick & Son..... 138

Calumet Engineering Works..... 130
Champion Machine & Forging Co..... 140
Clark Cast Steel Cement Co..... 142
Cleveland Crane & Engineering Co..... 115
Cleveland Fillet Co..... 141
Cleveland Nickel Works..... 51
Cleveland Pneumatic Tool Co..... 129
Cleveland Wire Spring Co..... 132
Coates Clipper Mfg. Co..... 38
Combined Foundry Supply Co..... 133
Comstock, Geo. S..... 127
Connersville Blower Co..... 126
Cox, W. W..... 149
Crescent Machine Co.....140
Curtis & Co. Mfg. Co..... 116
Curtius, Thos. M..... 148

Damascus Bronze Co..... 145
Davis-Bournonville Co..... 147
Davis, Geo. C. 149
Deane Steam Pump Co..... —
Debevoise-Anderson Co. 151
Demmler & Bros., Wm..... 26
Detroit & Cleveland Nav. Co..... 123
Detroit Core Sand Co..... 136
Detroit Hoist & Machine Co..... 116
Dixon, Joseph, Crucible Co..... 46
Dobson, William 136

Eastern Machinery Co..... 143
Engineers' & Founders' Laboratory..... 149

Falls Rivet & Machine Co. 8
Farnham Sand Blast Co..... 120
Federal Foundry Supply Co..... 6
Field & Co., Alfred..... 139
Foundry & Manufacturers' Supply Assn.. 144

Gardner Governor & Foundry Co..... 127
Gautier, J. H., & Co..... 48
General Electric Co..... 128
Goodale Co. 133
Goodrich, F. A., & Co..... 150
Gulick-Henderson Co. 149

Hanna Engineering Works..... 134
Hanna, M. A., & Co..... 150
Harbison-Walker Refractories Co..... 32
Harrison Supply Co..... 120
Hauck Mfg. Co..... 147
Hawkins, David S..... 149
Hawley Down-Draft Furnace Co..... 39
Herman Pneumatic Machine Co..... 20
High Pressure Sand Blast Co..... 120
Hillman, J. H., & Son..... 150
Holland Linseed Oil Co..... 12

Independence Mfg. Co..... 139
Independent Pneumatic Tool Co..... 129
Ingersoll-Rand Co. 129
Interstate Sand Co..... 134
International Flux Co..... 130

Johns-Manville, H. W., Co. 143

Keep, W. J..... 148
Kelly, T. P., & Co..... 4
Kerr Turbine Co..... 126
Kilting's Molding Machine Works, E..... 25
Knickerbocker Co. 121
Kroeschell Bros. Co..... 124

Levett Mfg. Co..... 105
Linn Mfg. Co..... 131
Lindsay, W. W., & Co..... 30

Maris Bros. 111
Masek, C., Glue Co..... 132
Matlack & Bates..... 150
Maurer, Henry, & Son..... 148
McCormick, J. S., Co..... 23
McCullough-Dalzell Crucible Co..... 47
McKeefrey & Co..... 150
Metal Dross Economy Co..... 130
Metal Mfg. Co..... 44
Metallurgical Laboratory..... 149
Midland Machine Co..... 137
Millett Core Oven Co..... 139
Milwaukee Correspondence Schools..... 142
Mohr, J. J., & Son..... 150
Monarch Engineering & Mfg. Co..... 41
Morgan Engineering Co..... 107
Mumford Molding Machine Co..... 27

Nash, Isham & Co..... 150
National Core Oil Co..... 11
New Era Mfg. Co..... 146
New Era Lustre Co..... 147
Newport Sand Bank Co..... 134
Niagara Device Co..... 136
Nicholls, Wm. H..... 116
Northern Engineering Works.....Back cover
Norwalk Iron Works Co..... 127

Obermayer, S., Co.....Inside front cover, 1
Ohio Sand Co..... 136
Osborn Mfg. Co..... —
Otis Elevator Co..... 114
Otis Steel Co., Ltd..... 143
Oxy-Acetylene Appliance Co..... 147

Paige Retort & Crucible Co..... —
Pangborn Company, Thomas W..... 7
Pawling & Harnischfeger Co..... 109
Paxson, J. W., Co.....2, 117
Peninsular Tool & Specialty Co., Ltd.... 132
Perry Iron Co..... 151
Pettinos Bros. 5
Philadelphia Chaplet & Mfg. Co..... 138
Phosphor Bronze Smelting Co..... 146
Pickands, Mather & Co..... 150
Pilling & Crane..... 150
Piqua Blower Co..... 128
Piqua Flour Co..... 131
Pittsburg Pneumatic Co..... 129
Pridmore, Henry E.....14, 15
Primos Chemical Co..... 45

Quincy, Manchester, Sargent Co..... 111

Randall Tramrail Co..... 111
Ridgway, Craig, Son & Co..... 113
Robeson Process Co..... 13
Rochester Foundry Co..... 138
Rockwell Furnace Co..... 124
Rockwell Co., W. S..... 123
Roessler & Hasslacher Chemical Co..145, 146
Rogers, Brown & Co.....150, 152
Roots, P. H. & F. M., Co.....Insert
Ross-Tacony Crucible Co..... 49
Rowlands Machine Co..... 137
Royal Ventilator Co. 105

Samuel, Frank 151
Sand Mixing Machine Co..... 134
Seaver, John W..... 149
Seidel, R. B., Inc..... 147
Sellers, Wm., & Co., Inc..... 135
Shanafelt Mfg. Co..... 31
Shelton Metallic Filler Co..... 28
Shepard Electric Crane & Hoist Co..... 109
Shuster, F. B., Co..... 142
"Sirocco" Engineering Co..... 126
Sly, W. W., Mfg. Co..... 125
Smith, J. D., Foundry Supply Co..... 9
Smith, Rudy & Co..... 149
Smooth-On Mfg. Co..... 29
Sprague Electric Co..... 116
Standard Pattern Works Co..... 140
Standard Sand & Machine Co..... 135
Sterling Wheelbarrow Co..... 132
Stevens, F. B.....Inside back cover
Stoughton Engineering Co..... 122
Stow Mfg. Co..... 115
Sturtevant, B. F., Co..... 125
Sullivan Machinery Co..... 127
Superior Charcoal Iron Co..... 150

Tabor Mfg. Co.....16, 17
Thomas Furnace Co..... 150
*Thompson & Co., Inc., Lewis..... 141
Tilghman-Brooksbank Sand Blast Co..... 121
Titanium Alloy Mfg. Co.....Front cover
Toledo-Massillon Bridge Co..... 109
Tropenas Steel Co..... 123
Turner Machine Co..... 142
Tuscora Sand Co..... 136

United Compound Co..... 139

Valentine, M. D., & Bro., Co..... 148
Vernon Metal Co..... 145

Walter-Wallingford & Co..... 150
Whitehead Bros. Co..... 3
Whiting Foundry Equipment Co.....52, 103
Wise, J. B..... 40
Wonham, Sanger & Bates..... 113

Yale & Towne Mfg. Co..... 115